THE ILLUMINATING ENGINEER

LIGHT
LAMPS
FITTINGS
AND
ILLUMINATION

THE JOURNAL OF
GOOD LIGHTING

Official Organ of the Illuminating Engineering Society

FOUNDED IN LONDON 1908

Edited by
J. STEWART DOW

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Vol. XXII | Engineering Library | December, 1929 | Price NINEPENCE
Subscription 10 6 per annum, post free
For Foreign Countries, 15/- per annum.

DEC 30 1929

Special Features:

The Nature and Effects of Glare—The Control of Public Lighting—Architectural Lighting—The International Illumination Congress (1931)—The Lighting of the Lecture Theatre of the Institution of Electrical Engineers—Electric Light and the Party—News from Abroad, etc.

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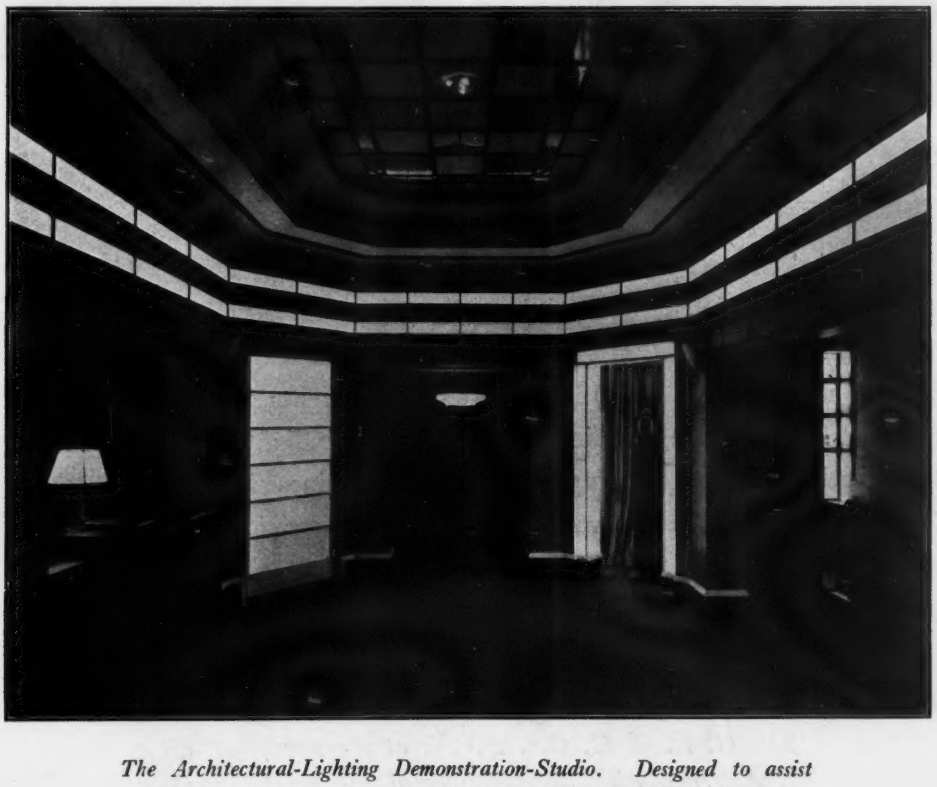

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EDITORIAL AND PUBLISHING OFFICES:
32 VICTORIA STREET, LONDON, S.W. 1.
Tel. No.: Victoria 5215

The Nature and Effects of Glare

IT is interesting to recall that "glare" formed the subject of one of the very first meetings of the Illuminating Engineering Society.* Mr. J. (now Sir John) Herbert Parsons opened the discussion, and many Continental experts expressed their views. Looking through this somewhat lengthy discussion one is impressed by the amount of data available on this subject more than twenty years ago. The simple rules laid down by Prof. L. Weber, of Kiel, are still applicable to-day. It was suggested by him that an installation might be considered glaring (*a*) if the ratio of the brightness of a source of light to its surroundings exceeded about 100 : 1, (*b*) if the brightness of the source exceeded the brightness of an open candle flame (about 0.4 candle per sq. cm.), (*c*) if the angle between the direction of vision and a line from the eye to the source of light was less than 30°, and (*d*) when the solid angle subtended by the source at the eye exceeded 5°.

Individually these rules are good, though it was perhaps hardly intended that an installation must comply with all of them simultaneously; for example, the brightness of a source might surely be permitted to exceed that of a candle flame if it were outside the normal range of vision, i.e., if its position complied with recommendation (*c*). The value of (*d*) is perhaps less evident than the others. Nowadays we are familiar with luminous sources of large dimensions. It does not appear that even such extensive luminous areas as those used in architectural lighting can be considered glaring, provided the brightness is moderate. Conditions resembling those indicated in (*b*) and (*c*) were embodied in the recommendations of the Home Office Departmental Committee on Lighting in Factories and Workshops, which, to our mind, still constitute one of the best series of rules yet framed for the avoidance of glare, at any rate so far as industrial lighting in concerned. An important principle arising from these recommendations was the desirability of a minimum "angle of cut-off" for industrial reflectors. To a factory manager, for instance, it is most useful to know that a unit with an angle of cut-off of 30° could be used almost anywhere in a workroom without offence to these recommendations.

To the writer it has always seemed that too little attention has been devoted to the first of Professor Weber's suggestions, which set a limit to contrast in brightness. Surely this condition goes to the root of the matter, for glare is essentially a matter of excessive contrast. Thus, an unscreened filament which is troublesome after dark appears inconspicuous in daylight, whilst the light of a match, though insignificant in a lighted room, is blinding when the match is ignited suddenly in complete darkness. Admittedly, however, this rule, whilst admirable in principle, is difficult to apply in practice unless one is provided with an instrument by which the brightness of all objects within the field of view could be compared.

Perhaps the chief development since those early days has been the recognition that different forms of glare exist. One of the most interesting points brought out in the admirable paper read by Mr. W. S. Stiles at the last meeting of the Illuminating Engineering Society (see pp. 304-9) is the distinction drawn between "disability glare" and "discomfort glare." The former impairs the ability of the eye to distinguish small changes in brightness; the latter causes visual discomfort (of which, again, there may be different varieties). Both forms of glare usually occur simultaneously, but not necessarily to the same degree, and the relation to such factors as brightness, candle-power and angular position of the source may not be the same in the two cases. Further, the relative importance of these two forms of glare varies according to circumstances. In one's own home "discomfort glare" is the more vital; in a factory both forms are perhaps equally important; in a street disability glare is usually considered the most serious.

In lighting interiors one is concerned mainly with contrasts in *brightness*, but when we come to deal with motor-car headlights and public lamps the problem becomes somewhat different. There is some ground for believing that in these circumstances, when the angle subtended by the source at the eye is usually small, candle-power rather than brightness is the most important factor, at least so far as "disability glare" is concerned. This idea formed the basis of the treatment of glare in the appendix to the British Standard Specification for Street Lighting. The "glare factor," as therein defined, is doubtless based chiefly on consideration of disability glare. At the Sheffield Conference it was suggested that a glare factor well within the limits of the specification might nevertheless cause considerable discomfort. However correct in theory the evaluation of glare on a basis of candle-power may be, one must admit that a lamp within a well-designed diffusing lantern has a vastly more pleasing

* *The Illuminating Engineer*, Vol. III, 1910, pp. 99-130, 170-190, 247.

appearance than an unscreened filament within a clear globe.

Admittedly it is difficult to legislate for appearance (with which visual comfort is closely associated) in a specification. Yet this important aspect should not be overlooked. At present there is some danger that public lighting engineers might draw the conclusion that candle-power is the only consideration, and that it is a matter of indifference whether the filament or mantle is screened or not.

The concluding part of Mr. Stiles's paper dealt with the difficult problem of testing glare. Hitherto rules and formulæ limiting glare have been based on general practice rather than on close scientific investigation. Mr. Stiles described detailed laboratory experiments on disability glare, and the ingenious test discs utilized in the streets of Sheffield last year showed that it is possible to devise quite useful practical tests. The apparatus then used, however, can hardly be described as portable. (Those who shared in the experiments on somewhat chilly nights will recall the gratitude with which the arrival of the motor lorry containing the testing implements was greeted!) What is needed is a portable apparatus which can be carried in the pocket and applied in any office or factory. A simple modification of the portable photometer, enabling the brightness of sources to be measured, would be useful. With a little additional design this might also enable disability glare to be determined.

The testing of visual discomfort is obviously more difficult. A practical test based on the comparison of the lighting unit with a series of frosted globes containing lamps of varying candle-power is described by Mr. Stiles. But such a test, though useful, is only a record of personal opinion, and cannot be readily applied *in situ*. Tests of the duration of after-images have sometimes led to useful results, but they are somewhat tedious, and the relation between the duration of such images and the intensity of glare requires further study. Most observers agree that exposure to glare causes visual fatigue, and some believe that prolonged work under such conditions is a contributory cause of deterioration in eyesight. When the eye suffers discomfort there are doubtless physical reactions that might be susceptible of measurement. Yet it is difficult to obtain statistical data supporting these beliefs, and still more difficult to contrive a simple test that would indicate the extent of discomfort and fatigue experienced. It is to be hoped that ophthalmic surgeons and oculists may ultimately be able to give us further information on these difficult points.

Obituary

T. P. O'Connor.

There must be many to whom the news of the passing away of Mr. T. P. O'Connor, the "father" of the House of Commons, will bring a deep sense of personal loss. There have been few men so widely known and so generally liked. To those who only knew him in his later years, who were familiar with his kindly, genial and tolerant nature, it seems incredible that in his youth he was a "stormy petrel" in politics. In his later years he had numberless friends and no enemies. "T.P." was one of the few survivors of a legendary age of romantic journalism, when penniless young men won their way, by wielding the pen, to fame and prosperity. His generosity ensured his response to any appeal in a good cause. As President of the British International Association of Journalists he shared with its late Honorary Secretary, Mr. Leon Gaster, a passion for peace and a keen desire to foster international friendship. Parliament has lost one of its greatest figures, journalism a brilliant representative.

The Control of Public Lighting

WE give elsewhere (pp. 315-316) a summary of the paper read by Mr. W. J. Jones at the Public Works, Roads and Transport Congress on November 22nd. Public lighting, in the technical problem, is becomingly increasingly complex. Mr. Jones outlines some of the latest developments in lamps and lighting apparatus, and alludes to such new problems as the lighting of arterial roads and the use of light for the guidance of traffic. But the main purpose of the paper is to draw attention to the need for central control of the lighting of London.

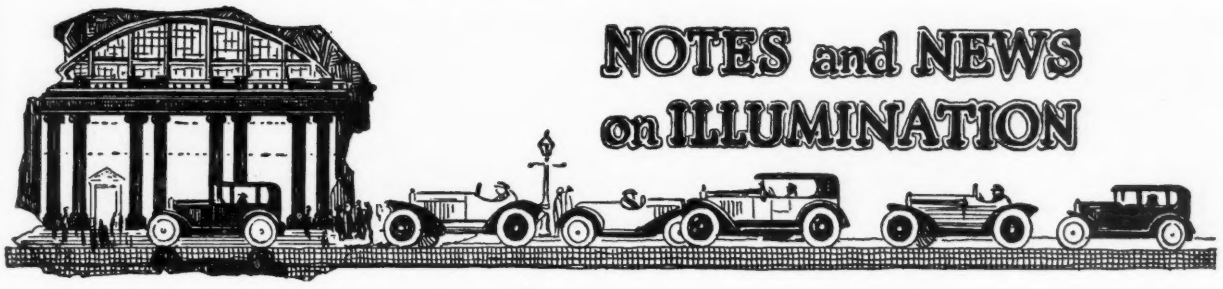
It is now 15 years since the late Mr. Leon Gaster dealt with this point in a paper before the London Society.* He pointed out then that within the area of the County of London there were approximately thirty different bodies responsible for lighting, and that whilst the greater part of the gaslighting was done by two big undertakings there were no less than 29 electrical supply undertakings interested. He contrasted the variety in aims and methods and the anomalies that characterize the lighting of London with the conditions existing in great cities abroad, and urged the need for some form of central control.

Now Mr. Jones gives battle on the same question. Since the date of Mr. Gaster's paper things have changed but little for the better. The nationalization of of electrical supply will, in course of time, doubtless eliminate the variety in pressures and systems of electrical supply now prevailing. But each borough remains responsible for the lighting within its area. Each adopts different methods, and its expenditure on public lighting may be determined by its wealth rather than by the actual requirements of the streets to be lighted. These requirements have become much more exacting during the past 15 years, owing to the continual growth in the volume of motor traffic. Whereas in most other fields of lighting there has been considerable progress, it may be doubted whether similar improvement has been made in the lighting of London as a whole, though admittedly the illumination of certain leading thoroughfares has been much improved. New problems, such as the design of luminous traffic signals, illuminated traffic and direction signs, etc., have arisen. Street-lighting requirements have been more fully outlined in the British Engineering Standard Specification for Street Lighting. The choice of equipment is now much more extensive and the technical knowledge available much greater.

We should like to support strongly the author's suggestion that a central organization should be created to survey the lighting of London. We also believe that some advisory body is needed to review public lighting throughout the country, and especially the lighting of arterial routes—a national rather than a parochial matter. The Ministry of Transport might well take the lead in this matter, enlisting the best expert aid available and sanctioning grants for adequate lighting in cases where this duty cannot be efficiently performed by the local authority. Standardization should be effected wherever possible, experiments should be conducted and permanent displays organized. Information collected should be at the service of local authorities throughout the country. Above all, this central organization should interest itself in the question of *appearance*, both of public lamps and standards and of devices for the guidance of traffic, and should frame rules to prevent rural highways being needlessly disfigured.

The facility with which light can be produced and applied to-day brings with it certain dangers. In the past lighting experts have naturally been preoccupied chiefly with the task of using the limited light available to the best advantage. But now decorative appearance should also be studied.

* *The Illuminating Engineer*, July, 1914, pp. 117-138.



The Illuminating Engineering Society

(Founded in London, 1909).

FORTHCOMING MEETINGS.

We understand that owing to the continued indisposition of one of the authors the proposed paper on "Kinema Studio Lighting" has been necessarily deferred until early in 1930. It has accordingly been arranged that the next meeting, on Tuesday, December 10th, will be devoted to a general discussion on "Problems in Illuminating Engineering." In past sessions these meetings have always been particularly interesting and successful. We gather that at the coming meeting such problems as the lighting of large vertical surfaces, the lighting of operating tables in hospitals, and novel theatre-lighting installations will be discussed, and there should be a good attendance. It will be recalled that the meeting in January is allocated to a paper on stage lighting by Mr. Harold Ridge, which will be delivered in the model theatre of the Royal College of Music, and will be illustrated by numerous demonstrations. This, too, should prove an entertaining and instructive evening.

Visit to the Post Office Tube Railway

Another forthcoming event is the visit, on November 27th, of members to the Post Office tube railway for the dispatch of mails, which was inspected by various members of the Council some time ago. The ingenious arrangement for the conveyance of parcels is well worth examination, and there are certain features of the luminous signalling devices of considerable interest to illuminating engineers. Owing to the small space available, the number of visitors on this occasion was restricted to ten, most of whom applied to join the party immediately after the announcement at the last meeting of the Society, on November 8th. We are asked to mention, however, that if sufficient other members desire to see this little railway another visit could probably be arranged during January next. Will any members who would like to take part in this second visit kindly send in their names to the Hon. Secretary (Mr. J. S. Dow, 32, Victoria Street, London, S.W.1)?

The Leon Gaster Memorial Fund

It is now approximately two months since the launching of the above fund, designed to commemorate the founder of the Society, primarily by the award of an annual premium for the best contribution on illuminating engineering submitted to the Society. We understand that the appeal has met with a prompt and generous response. One gratifying feature has been the manner in which corresponding members in other lands have come forward. There is already a good prospect of the minimum necessary sum being attained. At the same time, though the amount received up to date must be considered very satisfactory, we understand that quite a large number of members have not yet contributed. We would like to make it clear that the receipt of the requisite sum of money is not all that is needed. It is equally desirable that the contributions should come from as many people as possible. We feel sure that every member of the Society would wish to be associated with this memorial to its founder. All that is asked is that each member should contribute according to his means. No member need feel any hesitation in making a modest contribution, which will be received as gratefully as larger sums.

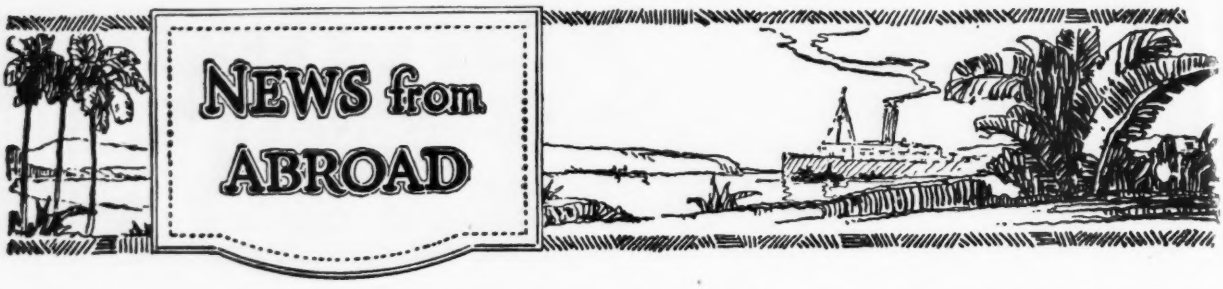
Automatic Signal Lights for the Control of City Traffic

We notice in *Safety First* an account of the chief features of luminous traffic-control systems, which have recently been summarized in the memorandum issued by the Ministry of Transport. It is commonly assumed that such systems are designed primarily as an aid to the guidance of street traffic. But the system, if wisely administered, should also be of considerable service to pedestrians—whose rights on the highway are apt to be somewhat overlooked. If pedestrians will accustom themselves to cross the streets at the recognized crossing places, and under the care of the signals, a marked diminution in the number of accidents which they at present suffer should result. Our contemporary has also something to say on the subject of "needless dazzle" from motor-car headlights. Many modern cars are now fitted with anti-dazzle devices, and it is urged that the Ministry of Transport should make the use of some means of reducing dazzle obligatory. Whilst the ideal has still to be sought there are many devices which are quite useful, and, according to *Safety First*, there is one effective remedy which anyone can adopt.

The circuit to the off-side headlamp is cut, and a switch inserted, which should be fitted on the steering-wheel or otherwise close to one's hand. The near-side lamp is permanently set so as to shine slightly downwards and towards the left of the road. The off-side headlight is switched off for the benefit of approaching traffic, the other headlamp giving a safe driving light, without dazzle, the side lights being both on. The whole thing can be fitted at an expenditure of a few shillings.

Football by Artificial Light

Some attention has been given in the press to the doings of a leading London rugby football club, which has organized evening practices by artificial light. In order to be more readily visible, the ball is coated with aluminium paint. It is apt to stray occasionally out of the illuminated zone, but nevertheless the experiment is stated to have proved a success. It is, of course, a more ambitious project to illuminate an entire football field so that the play may be watched at night by spectators. Yet this has recently been done at Newcastle, Pennsylvania, where a match played under these conditions was witnessed by about 12,000 people. The idea of playing the match at night seems to have been justified commercially by the expectation that many people would pay for entrance who would be otherwise occupied in the afternoon. The lighting was effected with 1,500-watt lamps in open-type extensive reflectors, mounted at a height of approximately 60 feet above the level of the field. The posts were spaced 75 feet apart on either side of the playing field, and the total consumption was about 63 kilowatts. One would not be at all surprised to find the playing of football matches by artificial light becoming more usual in this country, especially in league and cup-tie events, where the programme is overcrowded and time has occasionally to be found for extra events owing to drawn games or bad weather. Owing to the large size of the ball, football should be relatively easy to play by artificial light. The illumination of a field sufficiently well to enable the flight of a hockey ball to be followed would be less easy. Cricket would probably present still greater difficulties owing to the speed at which the ball travels and the great height to which it soars.



The International Exhibition at Barcelona

A recent contribution by Miss Beatrice Irwin to *The Electrical Review* contains a brief survey of exhibitions of the past in which lighting has played an important rôle and a somewhat detailed account of the spectacular arrangements at the International Exhibition held in Barcelona this year. The author remarks that the first serious attempt at decorative illumination on a large scale was at the Panama Pacific Exhibition. The Wembley Exhibition in 1922 and the Exposition des Arts Decoratifs in Paris in 1923 were also landmarks. A feature at Barcelona has been the display of illuminated fountains and cascades, for the lighting of which about 2,300 kw. were expended. The general decorative lighting of the Exhibition required 5,222 kw., and the total electrical demand for all purposes exceeded 20,000 kw. An interesting point is the way in which different countries have contributed to each display. Thus it is stated that France, Germany, America and Holland joined hands in much of the structural work of the "Grand Fountain." England furnished most of the mechanism of the cascades; America most of the reflector and searchlight systems, and Czecho-Slovakia the coloured glass. The changing opalescent colours of the fountains were much admired. Another novel device was the series of 116 crystal obelisks, each 18 ft. high, throughout the grounds. These were built in pale yellow and white glass, sufficiently opaque to conceal the internal mechanism which produces melting changes of colour every five minues.

A Degree in Illuminating Engineering

Systematic courses in illuminating engineering have been organized at quite a number of colleges in the United States, but it appears that Standford University is taking an unprecedented step in granting what is in effect a degree in illuminating engineering. This is a result of the course initiated about two years ago under the supervision of Dr. H. J. Ryan, executive head of the electric engineering department. The original idea of a few lectures on lighting developed into a three months' course, and subsequently a regular lectureship was established, so that illumination work became a permanent feature of the curriculum. Ultimately illumination was made one of the subjects in which a sixth-year student could specialize, obtaining a specific degree.

Magic Lantern Scenery

Readers may recall the display of the mutochrome projector in connection with Dr. Martin's paper before the Illuminating Engineering Society last year. This ingenious device enables coloured patterns to be built up in a marvellous manner. Its use on a large scale for stage effects has been proposed. With a model of this type it would be possible to project luminous scenery, which could be reproduced at any time by given combinations of colours and lenses. An apparatus on this scale would, however, be somewhat costly, and this is possibly one reason why it has not yet been applied. A somewhat less ambitious but apparently very effective device has recently been introduced in Austria. This may be regarded as a giant magic lantern for the projection of scenery. Owing to the wide angles involved, the lens system must be of special design, and it has been stated that each lantern slide costs about £8 to produce. The apparatus gives a certain stereoscopic impression, and the effect is said to be very fine. It would seem, however, that it does not accomplish all that a giant mutochrome might do, as with the latter the colours of any given scene can be modified to any desired extent, and, once the correct formula has been found, they could be imitated at any time afterwards.

Lighting Propaganda in Europe

A useful review of propaganda in favour of better lighting in the chief countries of Europe has appeared in *Lux*. Besides summarizing the work of the leading organizations interested in electric lighting, some reference is made to the various societies and journals concerned with illumination in its broadest aspects. Thus mention is made of the Illuminating Engineering Society, the Illumination Research Committee, and *The Illuminating Engineer* in this country. As the Society was formed in 1909, and the journal in the previous year, this country may well claim to have been in the vanguard in Europe. But it is worthy of notice that in its own field the E.L.M.A. Lighting Service Bureau has also done pioneering work, and that the similar organizations in other lands have been modelled on very similar lines. A collective picture shows views of the lecture halls of lighting propaganda centres in Paris, London, Berlin, Milan, Brussels, Vienna, Prague, Stockholm, Amsterdam and Budapest. The spread of activity to provincial centres in this country may be paralleled in France, where the initial organization of a centre by the Compagnie des Lampes in Paris has been followed by the opening of other centres in Lyons, Lille, Angers, Strasbourg and Mulhouse. In some cases the buildings where demonstrations take place possess interesting features—for instance, in Berlin, where the "Lichthaus" is unprovided with access of daylight and depends exclusively on artificial light. What is especially noteworthy is that all these activities have developed within the short space of five years. In some countries the organizations have hardly as yet got into their stride; their aggregate influence in the future should be very considerable.

A New Source of Ultra-Violet Light

In the last issue of *Light* Mr. M. Luckiesh describes a distinct novelty—an incandescent lamp utilizing a tungsten filament in proximity to a globule of mercury within a sealed glass bulb composed of special glass which permits the passage of ultra-violet radiation. The filament is stated to furnish about 7 per cent. of the light output, the mercury arc about 25 per cent., and the electrodes the remaining 68 per cent. The quality of light yielded is stated to resemble midsummer sunlight, but the capacity for producing tanning of the skin is said to be 20 times as great. The development of a powerful source of ultra-violet rays which can be operated with the same ease as an ordinary incandescent lamp is something of an achievement, and we shall watch its development with interest.

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

The Nature and Effects of Glare

Proceedings at the meeting of the Illuminating Engineering Society, held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 6-30 p.m., on Friday, November 8th, 1929.

A MEETING of the Illuminating Engineering Society was held at the house of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., on Friday, November 8th, 1929. Members assembled for light refreshments at 6-30 p.m., and the PRESIDENT (Dr. John W. T. Walsh) took the chair at the subsequent meeting, which commenced at 7 p.m.

After the minutes of the last meeting had been taken as read the HON. SECRETARY presented the names of applicants for membership, which were as follows: —

Ordinary Members:—

Bromley, L. C. .....Department of Scientific and Industrial Research, 16, Old Queen Street, London, S.W.1.

Barton, P. S.....Illuminating Engineer, "Nuria," Quaker's Lane, Potters Bar.

Fitz-Gibbon, A. D.....H.M. Office of Works, 50, Marchmont Street, London, W.C.1.

Hewett, H. .....Electrical Engineer, 85, Ellesmere Road, Dollis Hill, London, N.W.10.

The names of applicants presented at the previous meeting* were then read again, and these gentlemen were formally declared members of the Society.

The PRESIDENT then recalled the announcement, at the last meeting, of the Leon Gaster Memorial Fund. An appeal on behalf of the fund had since been circulated and had met with a generous response. A pleasant feature had been the interest shown by corresponding members of the Society in foreign countries. He had before him a letter just received from Professor Teichmüller, intimating that a contribution would be sent on behalf of the Lichttechnische Gesellschaft, of Karlsruhe. While the response to the appeal had been encouraging, there was still some distance to go before the sum contemplated by the Council was attained. He felt sure that every member would wish to be associated with this effort to commemorate the services of the founder of the Society, and the Hon. Secretary would be pleased to receive any further contributions.

The PRESIDENT then mentioned that the present evening had been assigned to a paper on "Kinema Studio Lighting," but owing to the indisposition of one of the authors the event had been unavoidably deferred until 1930. Mr. W. S. Stiles had very kindly stepped into the breach and consented to hasten the preparation of his paper on "The Nature and Effects of Glare" so as to be available for this evening. He felt sure that they all appreciated this effort on the part of Mr. Stiles, and he would now ask him to deliver his paper.

Mr. W. S. STILES then delivered his paper, the first portion of which was devoted to a discussion of glare in general. Various examples of glare met with in practice were mentioned. A distinction was drawn between "disability glare" and "discomfort glare." Methods of testing and evaluating them were discussed in detail, reference being made to the system of classifying light sources in terms of glare devised in the United States. The paper was illustrated by numerous effective demonstrations, showing how the presence of a bright source in the field of view tends to diminish the power of distinguishing contrast.

The PRESIDENT called upon Mr. W. J. JONES, who had been responsible for many of the experiments which accompanied the paper, to open the discussion. Amongst others who took part were Mr. A. CUNNINGTON, Mr. E. STROUD, Mr. J. S. DOW, Mr. H. BUCKLEY, Mr. L. E. BUCKELL and Mr. J. E. RAPHAEL.

After Mr. Stiles had briefly replied to various points raised in the discussion, and a cordial vote of thanks had been passed to him for his interesting paper, the President made several announcements. He explained that owing to the rearrangement of the programme of the papers it had been thought advisable to devote the next meeting, on December 10th, to the discussion on "Problems in Illuminating Engineering (originally proposed for February, 1930). He understood that a number of interesting problems had already been secured.

It was also mentioned that permission had been kindly granted for a small party of members to visit the Post Office Tube Railway, the date provisionally fixed for this visit being November 27th, at 6-30 p.m. The party on this occasion would be limited to ten. The Hon. Secretary would be glad to receive the names of any members who would like to participate in this visit, and, in the event of the number exceeding that specified, a second visit in January would probably be arranged.

Finally, the attention of members was drawn to the forthcoming Public Works, Roads and Transport Congress, which would be held at the Agricultural Hall, London, during November 18th–23rd. A paper entitled "The Application of Electricity to Roads from the Point of View of Street Lighting" was to be read by Mr. W. J. Jones, on Friday, November 22nd. Members of the Illuminating Engineering Society were invited to attend, and tickets could be obtained on application to the Hon. Secretary.

* *The Illuminating Engineer*, November, 1929, p. 279.

Physical and Optical Society

TWENTIETH ANNUAL EXHIBITION.

The above exhibition will be held at the Imperial College of Science and Technology, South Kensington, during January 7th–9th, 1930. The exhibition will be divided into (*a*) a trade section and (*b*) a research and experimental section, comprising exhibits by research laboratories and institutions, or individual research workers. A section for apprentices and learners has also been instituted. This exhibition, where there are usually numerous exhibits dealing with optics, photometry and illumination, will doubtless be of interest to members of the Illuminating Engineering Society.

The Nature and Effects of Glare

By W. S. STILES

(*National Physical Laboratory*).

(*Paper presented at the Meeting of the Illuminating Engineering Society, held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 6-30 p.m., on Friday, November 8th*, 1929.)

Introduction.

THE subject of glare requires little introduction to the members of the Illuminating Engineering Society. Nearly twenty years ago Sir John Parsons addressed the Society in a paper entitled "Glare, Its Causes and Effects."[1] There followed a long and notable discussion, in which scientists and technical men from all parts of Europe and America took part. This evening we are back once more to the same subject, and the question which, I think, will occur to many is "In what way and to what extent has the study of glare advanced in the last twenty years?" May I begin by indicating the answer to that question? I think the significant step forward has been the substitution of precise experiment and measurement to take the place of appraisal by personal opinion, conjecture and qualitative reasoning generally. My remarks this evening will be chiefly directed to show how modern experimental work is putting us within measurable distance of the quantitative evaluation of glare.

Glare Effects in General.

The term "glare" is used in everyday life, and also in illumination practice, to include a large number of undesirable effects which all arise in some way or other from excessive light. Other words—dazzle, dazzling, blinding, etc.—are also frequently applied in describing effects of this character, and no doubt different shades of meaning can be attached to these terms. It will be well, however, for the sake of simplicity, to confine ourselves to the use of the one expression "glare" to cover all the effects. Any attempt to frame a precise definition of glare beyond the loose statement made above is foredoomed to failure on account of the very varied character of glare phenomena. The answer to the question "What is glare?" consists in giving a series of examples, each typical of one or more manifestations of glare.

I suppose the easiest way to attract attention is to make oneself unpleasant, and there is no doubt that the unpleasant sensation experienced on viewing an intensely bright light is the most obvious manifestation of glare. The bare filament of an ordinary electric lamp, or an unshaded gas mantle, situated somewhere near the direction of vision, produces quite sufficient discomfort to cause us to take steps to shade the exposed light source. Discomfort effects are produced not only by very bright objects, such as the incandescent tungsten of the filament lamp and the glowing ceria of the gas mantle, but also by surfaces of extended area having a much lower brightness. A white road on a bright day can be almost intolerably bright. Another similar case is the discomfort glare experienced when walking over a snow-covered area, particularly in countries where snow is not incompatible with very clear and bright days. Discomfort glare may also be produced when passing from one set of brightness conditions to another, although neither set of conditions may be glaring when the eye has become properly adapted to them. For example, on entering a lighted room after being outside on a dark night, the light seems almost unbearably bright. After a few minutes, however, no further discomfort is experienced. Discomfort glare is a matter of such common observation that there is scarcely need to multiply examples.

If a light source is sufficiently bright to be uncomfortable, its effects on vision do not cease when it is removed from the field of view. At the place where the light source was situated in the field of view a series of after-images is formed which may persist seconds, minutes, or even hours afterwards, the duration depending on the intensity and length of the initial exposure. These after-images interfere with vision, firstly, because they are "false objects" and distract the attention, and, secondly, because they may obscure a real object situated at the same place in the visual field. A rapid glance at the sun is sufficient to bring out forcibly all the unpleasant effects associated with after-images. Less persistent after-images arise from the light sources ordinarily used in artificial lighting, but they are quite definite and easily observed.

The detection of glare discomfort and after-images calls for only the most elementary powers of observation. Another large group of glare phenomena, which in some cases are not so obvious, can be conveniently classed under the heading "reduction of the ability to see." Not only does a light source in the field of view produce discomfort and after-images, but it also makes it impossible to see low-contrast objects, and makes it more difficult to see all kinds of objects. It is important to make this statement precise by saying it is frequently the case that in the presence of glare the eye is less able to perform certain visual tasks, such as detecting low-contrast objects, reading test type, etc., than in the absence of glare, it being understood that the illumination of the objects to be seen is kept the same in the two cases. The latter proviso is important. The lamp you see here illuminates a contrast object on the screen behind. Owing to the glare effect, however, it is, I think, impossible for you to see this object. On screening the light source from your field of view, however, the contrast object is immediately visible. This is a good example of impairment of vision due to glare. Another way to eliminate the glare is to switch off the lamp. This does not improve vision; in fact, you can see nothing at all. In this comparison the proviso mentioned previously has not been observed; the illumination of the test object has been changed. It is well to emphasize that in all experiments dealing with the reduction in ability to see owing to glare, the general illumination of the test objects must be kept the same in the glare and no-glare cases, for otherwise the effect of the glare will be confused with other effects.

Good practical examples of glare interfering with the ability to see are observed when travelling by car at night. The headlights of an approaching car act as intense glare sources and inhibit vision of any objects in their immediate neighbourhood. Another case of glare, this time not involving a small bright light source, is provided when a window in the white wall of a house stands open on a bright day. It is impossible from the outside to see the contents of the room Inside the room, however, everything is easily distinguished.

An interesting case of glare, in which the conditions are the reverse of these, occurs when a central bright field is being viewed whilst the rest of the field of vision is kept absolutely dark. Vision under these circumstances is less good than when the surrounding field is feebly illuminated. This might also be described as a case of "darkness glare." One result of the dim lighting of cinemas even while the picture is being shown, is the improved vision of the screen which is obtained by the elimination of darkness glare.

Here is another example of reduction in ability to see owing to glare. This concerns speed of vision.[2] The pendulum, carrying a Landolt's broken-circle test object, is screened off in such a way that the test object is only visible as it swings past a narrow slit. For a fixed amplitude of the pendulum the velocity of the test object can be varied by altering its position on the pendulum. It is found that the orientation of the gap in the test object can be correctly assigned for velocities up to a certain limit, depending on the illumination. When a glare source, an ordinary electric lamp, is placed by the side of the slit the limiting velocity is found experimentally to be considerably reduced. The glare has reduced the speed with which the orientation of the test object is recognizable.

Discomfort is experienced directly, reduced visibility is subject to measurement, but other effects such as eye fatigue, eye strain, etc., which are believed to be frequently due to glare, are more difficult to establish. As Sir John Parsons remarks: "The disagreeable effects of a bright light in the field of vision are familiar to everyone, but the cause of the distress and *how far it is seriously detrimental to the eye* have proved difficult to discover."

It is customary to associate conditions of glare with subsequent eye strain, which, according to some authorities, may result in diseases of the most diverse character, for example epilepsy, lateral spinal curvature, but definite evidence to establish the connection is almost impossible to obtain. Eye fatigue suggests itself as being rather easier to subject to measurement, but here the experimenter is faced with the many times demonstrated ability of the eye, when called upon to function for a certain test period under adverse conditions, to rise to the occasion and do as well, or even better, than when the lighting arrangements are more favourable. Of course, ultimately there must be a reaction, but this is difficult to bring within the scope of an experiment.

Sufficient has been said, I think, in this introduction to indicate the general nature of glare effects, but the list is by no means exhaustive. However, the principal effects have been indicated, and we can turn now to what has been accomplished by scientific investigation of the problem, as the first step towards the elimination or at least the minimization of glare.

The Evaluation of Glare.

That glare effects are undesirable has always been realized more or less completely, and steps have been taken, sometimes unconsciously, to eliminate glare. As glare is commonly associated with light sources attention has been concentrated on eliminating glare by modifying the light source in order to produce what is sometimes spoken of as glareless light. Most of the devices directed towards this end amount in effect to a lowering of the surface brightness of the light source. Other attempts to deal with glare rest on the notion of sorting out from the light, either at the source or at the eyes, those rays which it is considered do most damage to the eyes. Finally, the use of shaded fittings, of indirect and semi-indirect lighting systems, represents still another method of dealing with the problem. Most of these devices and methods have some element of truth behind them, but the particular manifestation of glare which is eliminated by one scheme may be entirely different from that eliminated by another, and the elimination of one glare effect may leave another fully active. We must be reconciled to the fact that there is no universal panacea for glare. There does not exist any particular variety of light which can be called glareless light. The problem of glare confronting the illuminating engineer is to design lighting installations in which all the different glare effects are reduced to a minimum. It is essentially a problem of installation design; the particular light sources and the fittings employed are only one factor entering into the problem.

Before there can be any question of designing to give minimum glare conditions the laws relating the glare produced with the brightness, candle-power, and positions of the glare sources must be elucidated. Quantitative measurements of glare must be made, so that given two proposed lighting systems it may be possible to forecast which will produce more discomfort glare, which will reduce more the ability to see. The quantitative evaluation of the most important two manifestations of glare, discomfort and reduction in ability to see, has at the present time reached a stage at which cautious application of the laboratory investigations to practical cases is permissible. The presence of discomfort is a fairly reliable indicator of a number of other glare effects, fatigue, after-images, eye strain, etc., and the elimination of discomfort is almost certain to lead to amelioration in these other directions. Reduction in ability to see is, however, an effect independent of discomfort in that although it often accompanies discomfort this does not always occur, and, on the other hand, the ability to see may be reduced without perceptible discomfort. The truth of this remark will be realized after the experimental laws governing the two effects have been dealt with. More work has been done on the reduction in ability to see, as this is a more definite problem, and we shall consider first the results obtained in this direction. Perhaps I may be permitted at this stage to coin a new term and speak of "disability glare" as distinct from "discomfort glare."

Disability Glare.

Suppose an observer O is viewing a surface S illuminated to a brightness B, at a certain point P of which he has to carry out some visual task. This might be reading test type, picking up low contrasts, or detecting brief flashes of light. It is assumed that the sources illuminating the surface are completely screened from the observer's field of view. For a given brightness B the

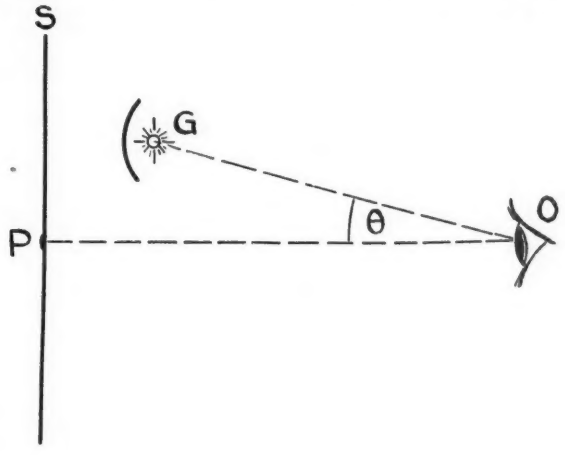


FIG. 1.

efficacy with which the visual task is performed is measured. This might be the smallest size test type readable, or the least contrast detectable, etc. Let now a glare source be introduced into the field at the point G so that it is visible to the observer, but by suitable arrangements is prevented from increasing the illumination on S. The tests with the visual task are now repeated, and it is found that the test type must be larger before it can be deciphered, the contrast greater before it is picked up, etc. The ability to see is reduced, and it is clear that the method gives a quantitative measure of the reduction.

Any visual task might be employed in the investigation, but the one that has been used principally is the the determination of the smallest difference of brightness perceptible. All objects are seen because they present to the eyes a system (usually very complex) of brightness contrasts.* It is a well-known fact of physiological optics that if the difference of brightness between two contiguous surfaces is steadily reduced a point is reached finally when the eye is unable to perceive that there is a difference of brightness, although it can be shown that the difference in physical brightness is not zero but has a finite although relatively small value, known as the brightness difference threshold. If the brightness contrasts of the object all fall below this value the object is invisible. If the brightness contrasts are small or large, compared with the brightness difference threshold, the object is respectively difficult or easy to see. The importance of the brightness difference threshold in vision is easily realized.

A word as to how the brightness difference threshold is determined experimentally will be of interest here.[3] Referring again to Fig. 1, a test spot of light is projected on to the surface S at the point P. If δB is the additional brightness due to this light, the difference of brightness between the test spot seen at the point P and

* The complication of colour contrasts is omitted. The discrimination of coloured objects raises special points which will not be touched upon here.

the surrounding field will be given by $B + \delta B - B = \delta B$. δB is varied until the spot is (*a*) just detectable, (*b*) just not detectable, and the mean of the values obtained in this way gives the brightness difference threshold. When there is no glare source in the field δB varies in a very characteristic way with B, which is best seen by plotting $\frac{\delta B}{B}$ against $\log_{10} B$ (see Fig. 2). $\frac{\delta B}{B}$

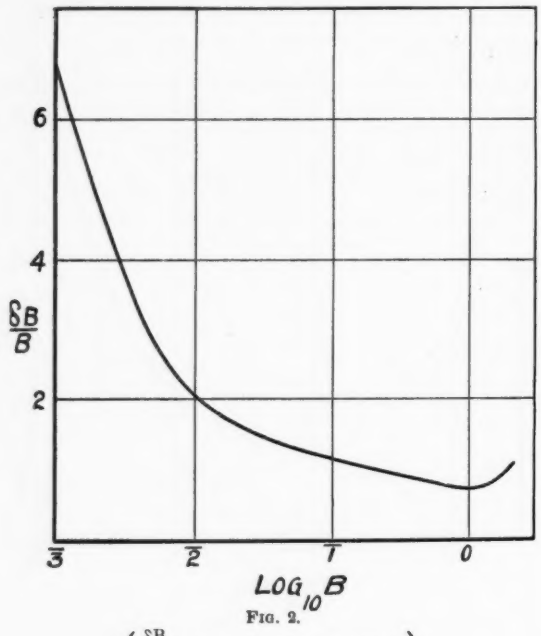


FIG. 2.

($\frac{\delta B}{B}$ is expressed as a percentage.)

has a minimum in the neighbourhood of B = 1 candle/square foot, then slowly rises as B decreases until B = approximately 0.01 candle/square foot, at which point it shoots up rapidly.

Suppose now the glare source at G be switched on, what is the effect on δB? Experiment shows that δB increases, i.e., vision is less good. That is the fundamental fact, but a great deal more has been found out than that, and I shall attempt to give in a few words the principal results of the investigations and demonstrate these results by a few simple experiments. The effects of the following factors have been examined:—

(1) Brightness, candle-power, distance, and area of the glare source.

(2) Brightness B of background.

(3) Angle of separation θ between glare source and direction of vision.

(4) Colour of the glare source.

(5) Addition of further glare sources.

With respect to (1) the general result has been established that provided the glare source is not too big, i.e., provided its diameter doesn't subtend at the eyes an angle exceeding a certain limit, which equals about 1°, the effect on the brightness difference threshold is quite independent of size and brightness, and depends only on the candle-power and position of the glare source.[4, 5] It follows that substituting for a bare filament lamp a frosted or opal glass lamp will not decrease the disability glare effect except in so far as the candle-power of the lamp is reduced, which is in general not very much.

It must be observed that it does not follow, and is not true, that the *discomfort* effects will be the same in the two cases. Moreover, if the eyes are very near to the opal bulb the angle subtended at the eyes will exceed 1°, and the equivalence between bare-filament lamp and opal lamp will no longer hold good. In many cases, however, the light source subtends a small angle at the eyes, and the result which has been established is therefore of considerable practical importance.

As regards the other factors under (1), the greater the candle-power of the glare source and the nearer it is to the eyes the greater the increase in δB. The determining magnitude for a given angle of glare θ has been shown to be the vertical illumination produced at the eyes by the glare source.

Increasing the background brightness B very definitely mitigates the effect of the glare source, for although δB increases $\frac{\delta B}{B}$ decreases, and this is the more important magnitude in practice.

The position of the glare source in the field, as determined by θ, has an enormous influence on the glare effect. The nearer the glare source to the point viewed P the greater the rise in δB (and of $\frac{\delta B}{B}$ too, since B is assumed kept constant). A weak glare source near to P may quite easily be more detrimental than a much stronger source situated farther away.

The experiments on the effect of changing the colour of the glare light are not conclusive. The results seem to show, however, that, whether blue light is more glaring than red or vice versa, the effect can only be small and of secondary importance.

Finally, if two glare sources produce separately increases in δB equal to δB_1 and δB_2 respectively, then the two glare sources present together in the field produce an increase δB equal approximately to $\delta B_1 + \delta B_2$, i.e., their effects are additive.

All these results can be summed up in a quantitative formula. For any given glare condition, δB is determined by measurement. By reference to the results obtained in the absence of glare it is then possible to find a background brightness β for which the least perceptible difference of brightness has just this value δB. β is termed the equivalent background brightness of the glare condition. It turns out that the results of the threshold experiments can then be represented by the formula

$$\beta = B + \frac{kE}{\theta^n} \quad - - - - - - - (1)$$

where E is the vertical illumination produced at the eyes by the glare source and k and n are constants.[6] Expressing β and B in candles/square foot, E in foot-candles, and θ in degrees, experiments carried out recently[3] show that $k = 4.16$, $n = 3/2$. If there are two glare sources in the field β is given by

$$\beta = B + k\left\{\frac{E_1}{\theta_1^n} + \frac{E_2}{\theta_2^n}\right\} \quad - - - - - - - (2)$$

It will be noted that the brightness difference threshold has entirely disappeared in this way of stating the results. I am of opinion, and there is some evidence in support of this view,[7] that the same equivalent background brightness formula would have been obtained whatever the visual test used in the investigation. If so, the quantity β gains greatly in importance. In any case it is a very suitable magnitude to use in defining a glare figure.

The measure of the disability glare experienced when looking at P is defined as follows:—

$$G = \frac{\beta}{B} = 1 + k\frac{E}{B\theta^n}$$

If there is no glare source present G = 1, which corresponds to the best conditions attainable. The introduction of a glare source in the field increases G by the amount $\frac{k}{B}\frac{E}{\theta^n}$, and to avoid serious disability glare this quantity must be kept small.

What is the value of G in certain interesting practical cases? We shall take three examples: (1) Consider two cars with similar headlight equipment approaching on a level straight road. Suppose the headlights fitted with 24-watt lamps, adjusted to give minimum divergence, and directed so that the light beams hit the road 100 feet in advance of the car. The driver's eyes being glued on the bright patch of roadway 100 feet ahead, what is the glare figure when the cars are 50 feet apart?

Assuming probable values for road width and reflection factor, mounting height and distance apart of headlights, etc., calculation leads to the following results:— The brightness of the roadway 100 feet ahead is given by B = 0.0012 candle/square foot. Applying the formula (2) given above, the equivalent background brightness comes out to be β = 0.0012 + 4.16 [0.002 + 0.024], where the first term in the bracket arises from the nearside headlight of the approaching car and the second term from the offside headlight. Finally, G is given by $G = \frac{\beta}{B} = \frac{.0012 + .098}{.0012}$ = 83. This is a very large value of G, and means a much reduced visibility. It is interesting to note that the glare effect of the nearside headlight is only 1-12th of that of the offside headlight. (Switching off the latter and doubling the candle-power of the former would reduce the glare figure to 14.) It has been assumed there is no street lighting. If a Class E installation (British Standard Street-lighting Specification) is present this increases the road brightness and reduces G from 83 to 4. Even a Class H installation has some effect, G becoming 24 instead of 83.

(2) As second example, let us take the glare due to a series of street lamps. In some installations tested at Sheffield last year data were obtained which suffice for the approximate calculation of G for the position of worst glare in the street. G values ranging from 1.4 to 5.6 are obtained from these data, all the installations being in Classes D E or F of the British Standard Specification.

(3) Finally consider the G value in an ordinary room with medium light walls (reflection factor 0.3), and dimensions 10 feet high, 15 feet square. Suppose the light source unshaded and suspended 2 feet from the ceiling. For horizontal vision in the worst position in the room G comes out to be 1.3 It is to be noted that precisely the same value is obtained whether the light source is a bare filament lamp or an opal bulb, and, further, the result is independent of the candle-power, for B and E increase together, and leave the quantity $\frac{k}{B}\frac{E}{\theta^n}$ unchanged. I do not think the increase of G from unity (absence of glare) to 1.3 is a very serious reduction in visibility, and the objection to bare filament lamps in an ordinary room can scarcely be based on the disability glare produced.

Discomfort Glare.

Although it is seen to be possible to measure the effect of glare on the ability to see, it is a much more difficult problem to evaluate discomfort. At first sight it appears that almost any attempt in this direction reduces ultimately to a determination of some *capacity* of vision. There are two methods of attack, however, which have given interesting and valuable results. These may be termed the threshold method and the comparison method. In the threshold method, as used originally by Nutting,[8] the experimental procedure was briefly as follows. The observer viewed an extended field of uniform brightness B, at the centre of which a smaller field, in general of much higher brightness Bg, was placed. Keeping other conditions unchanged, the brightness Bg could be varied until a just perceptible sensation of discomfort was experienced. The critical value of Bg found in this way changed with variation of B in accordance with the equation

$$\log_{10} Bg = 2.8 + 0.32 \log_{10} B \quad \text{or} \quad Bg = 690\, B^{0.32},$$

the range of B investigated extending from 3.10^{-7} to 3.10^{3} candles/square foot. Later work on the same lines by Holladay and Luckiesh[9] gave results which tallied with Nutting's equation, and, in addition, brought out the further important point that varying the size of the glare field (as measured by the angle subtended at the eye by the field diameter) from 0.4° to 7.1°,[7] had no appreciable effect on the critical brightness for discomfort. This implies that as far as the discomfort effect measured in this way goes, the illumination produced at the eyes by the glare source is unimportant, the *brightness* of the source being the determining factor. This is in sharp contrast to the disability glare effect considered previously. Another point of difference between discomfort and disability glare, shown by Nutting's experiments, is the comparative slowness with which the discomfort effect falls off as the glare source moves away from the centre of the field. A separation of the glare source from the centre, equal to 20°, permitted an increase of the brightness Bg of only 50 per cent. Compare this result with the fact that the disability effect at $\theta = 20°$ is something of the order $\frac{1}{100}$th of its value at $\theta = 1°$. The angle of glare appears to be relatively unimportant in the discomfort effect.

It must be remembered that all the above results are derived under conditions of more or less steady gazing, the observer being exposed to the glare condition for some minutes before making his judgment. When the glare source is exposed only momentarily the conclusions are modified. In the first place, a higher brightness is tolerable, and, secondly, the size of the glare source now enters as a controlling factor in addition to the brightness. Luckiesh and Holladay[9] have made a daring extension of the threshold method in examining the sensation experienced on momentary exposure to a glare source and sum up their experimental results in the formula

$$\log Bg = C + 0.3 \log B - 0.25 \log Q,$$

where Q is the solid angle subtended by the glare source at the eye, in steradians, and C is a constant. For a given general field brightness B and given size of glare source Q, the glare source brightness Bg, which will just produce a perceptibly uncomfortable sensation on momentary exposure, is given by the formula with C put equal to 1.84. With C put equal to certain other values, the formula gives the critical brightness Bg necessary to call forth other grades of sensation as shown in the accompanying table:—

TABLE I.

C	Description of Sensation
−1·95	Scarcely noticeable.
0·25	Most pleasant.
0·60	Still pleasant.
0·89	Limit of pleasure.
1·09	Very comfortable.
1·33	Still comfortable.
1·43	Less comfortable.
1·53	Limit between comfort and discomfort.
1·84	Perceptibly uncomfortable.
1·99	Uncomfortable.
2·15	Thoroughly uncomfortable.
2·22	Limit between objectionable and intolerable
2·40	Irritating (higher values painful).

Although these results, depending as they do on subtle differentiation of sensations, must be treated with reserve until independent confirmation is forthcoming, I think the underlying notion of the method is sound.

It will now be of interest to apply the limiting comfortable brightness formulæ to one or two practical cases.

Consider the living-room example introduced previously. The brightness of the walls at about the lamp height is given by 0.0019 I candle/square foot, where I is the candle-power of the light source. What is the highest brightness of the source permissible, according

TABLE II.

I	Maximum Permissible Brightness of Source	Source	Intrinsic Brightness
40 candles	Candles/sq. ft. $0·039 \times 10^4$	High Pressure Gas	Candles/sq. ft. $2·3 \cdot 10^4$
100 „	0·051	Carbon Filament	5·1
200 „	0·063	Tungsten Vacuum	12·0
300 „	0·067	Tungsten Gasfilled	56 to 124

to Nutting's formula? In Table II this is given, assuming different values of I. In the same table the brightnesses of a number of common light sources are given. It is seen clearly that these brightnesses range from 30 times to 3,000 times the permissible brightness, in the extreme cases. This corresponds to a very high degree of discomfort glare in a room illuminated by the bare light source. It will also be noted that as the candle-power I of the lamp increases, the maximum permissible brightness also increases. It is not quite so bad to have bare sources in a brightly illuminated room. On the other hand, this increase is not so marked when very high candle-power lamps, 300 candles or more, are used. Suppose a 200-candle-power lamp is being employed, what is the gain by using an opal glass bulb? The brightness of the opal glass bulb in this case equals about 0.2×10^4 candles/square foot. Thus it is now only some three times the maximum permissible brightness against some 1,000 times when a bare gasfilled lamp is used. In order to get the surface brightness of the light source down to the just permissible value, calculation shows that a globe of 8 inches diameter is required. Many diffusing-glassware lighting units employ bowls and globes whose dimensions are of this order. Measurements[10] on these bowls have shown that the surface brightness, when a 200-watt lamp is used in the fitting, falls well within the maximum permissible brightness worked out above for a usual size living-room.

A word here about the use of pearl lamps, i.e., frosted lamps. These are not so good from the point of view of elimination of discomfort glare as opal lamps, but they are, I believe, a little cheaper, and represent certainly an advance on the exposed filament lamp. The bright spot in the pearl lamp occupies an area equal to about 20 per cent. of the total area. The brightness is therefore about five times that of the equivalent opal lamp. The glare effect is, however, mitigated somewhat by the *relatively* bright surround, i.e., the outer parts of the bulb.

The second method which has been developed for estimating the discomfort effect of glare is the comparison method.[11] In this method, as developed in the U.S.A., a number of standard sources of glare are prescribed, and these are compared in turn with the glare source to be tested. The test source and the comparison source are set up side by side and are viewed against the same background. In this way the glare effect of the source is graded in an arbitrary scale varying from A to K, the standard sources corresponding to the different grades being given in Table III.[12] It is found

TABLE III.

Grade	Standard
A	10 w. tung. fila. lamp in 6″ frosted ball globe.
B	15 w. tung. fila. lamp in 6″ frosted ball globe.
C	25 w. tung. fila. lamp in 6″ frosted ball globe.
D	40 w. tung. fila. lamp in 6″ frosted ball globe.
E	50 w. tung. fila. lamp in 6″ frosted ball globe.
F	60 w. tung. fila. lamp in 6″ frosted ball globe.
G	100 w. tung. fila. lamp in 6″ frosted ball globe.
H	150 w. tung. fila. lamp in 6″ frosted ball globe.
I	300 w. frosted lamp.
J	500 w. frosted lamp.
K	1,000 w. frosted lamp.

that, using this method reasonable agreement is obtained between the gradings of a given glare source by different observers. From experiments of this type it has also been concluded that the most important single factor involved in the discomfort effect is the illumination produced at the eye by the glare source. This result is at variance with Luckiesh and Holladay's conclusion using the threshold method. In Table IV[12] are given the gradings of a number of common light sources, in the A to K classification, as quoted recently by the American Committee on Factory and School Lighting.

Although the comparison method possesses the great attraction of giving a direct answer to the question as to how much discomfort glare a given fitting produces, I think the following points should be kept in mind in assessing the merits of the method as developed up to now. In the first place, the method relegates to the background the attempt to relate the discomfort effect to the fundamental physical variables on which it must

TABLE IV.

	Grade.
Natural Light Sources (as seen through windows)	
Sun	K
Bright Southern Sky	G
Dull or Northern Sky	C
Sun Shining on Prism Glass	J
Mercury Vapour Tubes	G
Carbon Incandescent Lamps	
16 Candle-power	F
32 Candle-power	G

Tungsten Filament Lamps	Watts					
	40	60	100	150–200	300	500–1,000
Bare lamps	G	H	I	J	J	K
Frosted lamps or frosted globes	D	F	G	H	I	J–K
8″ opal globes*	C	E	F	—	—	—
12″ opal globes	—	—	E	G	H	I
16″ opal globes	—	—	—	F	G	H
Flat reflectors—Filament position visible	G	H	I	J	J	K
Dome reflectors—steel or dense glass: Filament position visible from working position	G	H	I	J	J	K
Filament position not visible	B	B	D	D	E	G
Dome reflectors—White bowl lamps	—	—	—	F	G	G
Bowl reflectors—steel or dense glass: Filament position visible	G	H	I	J	J	K
Filament position not visible	C	C	D	E	G	H
Totally indirect lighting	—	—	B	B–C	C	D
Semi-indirect bowl*	—	—	B–D	C–D	C–E	D–G

* Where a range is given, the best grade, that is, the lowest, applies to bowls that are of dense glass, and the poorest to bowls which have a decidedly bright spot in the centre.

depend, namely, the exposure time, the brightness, candle-power and position of the glare source, and the brightness of the background against which it is seen. Furthermore, it is a little difficult to be sure that what is being equated by the observer is, in fact, the discomfort effect, and not, perhaps in some cases, the brightness; in others the candle-power, etc. The settlement of a suitable scale of standard glare sources is also likely to prove a controversial matter. Nevertheless, any method of attack on this difficult problem is welcome, and should be continued, although, of course, not to the exclusion of the more fundamental investigations.

Physiological Mechanism of Glare.

In the evaluation of glare different effects have been seen to obey different laws, and we may expect to find different physiological mechanisms operative in these cases. It has been found convenient in the above to distinguish between two important groups of glare phenomena, disability glare and discomfort glare. There is, I think, a corresponding distinction in the physiological mechanism. In the simple case of a point source of glare viewed at a given angle from the visual axis, the image of the glare source on the retina is separated by a corresponding distance from the fovea centralis, or point of most distinct vision. In disability measurements the retinal conditions at the fovea centralis are principally involved. The glare-source image will control disability measurements by propagation of its effects in some way or other through the retina, and it is reasonable to expect that the effect some distance away at the fovea centralis will be determined almost solely by the total light in the glare image, other peculiarities, such as intrinsic brightness, being smoothed out in the propagation process. It is also to be anticipated that as the glare image approaches the fovea the disability effect will increase rapidly. Take now the discomfort effect. The sensation is in great part localized at the glare-source image, and the brightness as well as the total light in the image may both be controlling factors in the effect. Shift of the glare source on the retina will change the localized discomfort effect only to the extent that the intrinsic properties of the retina change from place to place. Variation of retina sensitivities does, of course, occur, but such changes are comparatively gradual.

These remarks show, I think, that some of the most characteristic properties of disability and discomfort glare effects can be anticipated in a general way by an elementary examination of the conditions of vision at the eye. The working out of the detailed explanations is a problem for physiology.

Conclusion.

A brief paper on the nature and effects of glare cannot avoid being fragmentary. I find I have said next to nothing about glare effects which occur when passing from one set of brightness conditions to another. I have had no time to deal with the interesting experiments of Ferree and Rand on discomfort glare produced by different lighting systems—direct, semi-indirect and indirect. I hope, however, that I have been able to make clear the possibilities of measurement of glare effects, and the fundamental distinction between disability and discomfort glare.

In conclusion, I take this opportunity of thanking Messrs. W. J. Jones and T. F. H. Marsh, of the E.L.M.A. Lighting Service, and Messrs. B. H. Crawford and H. R. Sayers, of the National Physical Laboratory, for their valued assistance in preparing the demonstrations.

APPENDIX

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[11] Harrison, W., *Trans.* I.E.S., N.Y., XV, 1920, p. 34.

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Discussion

The CHAIRMAN remarked that the subject of glare was of great importance to every illuminating engineer, and he was sure that there would be an interesting discussion. He would call upon Mr. Jones, who had helped considerably in the preparation of experiments to illustrate the paper, to address the meeting.

Mr. W. J. JONES agreed that the subject of the paper was a vital one. He was very glad to find that the author had approached some of the problems from fundamental principles. Mr. Stiles had quite rightly discriminated between disability glare and discomfort glare, and had indicated how difficult it was to assess the effect of the latter form of glare. There was, he thought, a disposition to overestimate the importance of disability glare, particularly having regard to some of the transient conditions under which the eye operated. In a street, for instance, the conditions as far as the eye was concerned were changing at every foot, and that was equally true of the factory and of the home. Therefore, one should not be too dogmatic on the question of the limits to be imposed.

Discomfort glare was a matter which deserved the earnest attention of medical research workers, who should investigate its relationship not only to vision but to the functions of the body and health generally. As Mr. Stiles had pointed out, the two forms of glare were not directly related. It was possible to experience discomfort and not find undue disability, but there might quite well be a reaction due to fatigue or eye strain which must tell in time.

The question of contrast entered into many practical problems. With regard to the lighting of an operating table, for example, one found intensities of the order of a hundred or two hundred candles or more. The area surrounding the spot where the operation was to take place might form a species of patchwork. There were white swabs and white towels. When the incision was made colour contrast entered into the question. Gory-coloured towels might possibly improve the surgeon's ability to carry out his task.

He would like to say how glad he was that the matters under consideration had been dealt with in the manner in which Mr. Stiles had handled them. He hoped that in due course it would be possible to make practical application of some of the work that Mr. Stiles had done.

Mr. A. CUNNINGTON said that during the reading of the paper there had been passing through his mind an effect of an analogous kind which might possibly have some relation to glare. He would like to put his remarks in the form of a question. Did Mr. Stiles think the effect of the flicker which one obtained with a low-frequency supply could be studied by some of the formulæ which he (Mr. Stiles) had put forward? There had been a good deal of complaint in connection with the use of a 25-cycle supply for lighting purposes. He had experimented with different kinds of lamps, globes and fittings to ascertain what would be most likely to eliminate flicker. All that one could conclude definitely was that the removal of oneself to the greatest distance from the source was the best method to adopt. If the source was at the end of a room, say 20 ft. away, the flicker was not detectable, however bright the source, but when one approached nearer to the source the flicker became very apparent. So far as he had been able to judge, the effect with different types of fittings was the same. Was there any simple explanation of the effect, and was it closely connected with glare? Was the phenomenon really analogous to the glare of a steady light?

Mr. E. STROUD stated that some time back he had been much concerned with the question of glare, chiefly in connection with street lighting, and Professor Bordoni's experiments had been brought greatly to the fore. He believed that Bordoni's limit to the flux of light entering the eye assumed the source subtended at the eye an angle of not more than 3°. Mr. Stiles, however, had taken 1°. He (the speaker) would like to know whether subsequent experiments had shown that 1° was the correct limit.

Mr. J. S. DOW complimented Mr. Stiles on his painstaking and thorough paper. He recalled that one of the very first discussions before the Society had dealt with glare. At that time it was usual to attach importance mainly to brightness. He himself had always felt that "contrast in brightness" was the fundamental point that determined intensity of glare. Prof. L. Weber had suggested the rule that the limit of contrast in brightness of objects within the field of view should not exceed 100: 1. When this rule could be complied with there should be little glare.

The disability glare mentioned by Mr. Stiles might, however, arise with quite moderate contrasts, and in cases where there was no apparent discomfort. This might explain why workers so often preferred local shaded lights, especially when working with dark material. If an operator was examining dark cloth its brightness might be much less than that of the surroundings when uniform general lighting was provided. The contrast was in the wrong direction, and this made it difficult to see well. Doubtless the aim should be to make the actual working material the brightest object in the room.

There had been some tendency recently to argue that glare depended on the total flux of light entering the eye, i.e., on the candle-power of the source rather than its brightness, provided the angle subtended was sufficiently small. In the case of very distant motor-car headlights or street lamps this might well be true. But he thought that Bordoni's experiments in this direction had been somewhat misinterpreted.

Mr. Dow proceeded to show that the angle subtended at the eye in ordinary circumstances by street lamps was of the same order as the angle subtended by the bright central patch of an internally frosted lamp, viewed by a person examining a shop window. If, as the treatment

of glare in the British Engineering Standard Association implied, glare was a matter of candle-power, it might well be argued that the same consideration applied to lamps in a show window. Yet he did not think anyone would agree that the glare from a filament in a bare bulb was no greater than that from an internally frosted one—notwithstanding the fact that the candle-power was practically the same.

There was some danger that a public lighting engineer, examining the specification for the first time, might draw the conclusion that it was immaterial whether lamps were furnished with diffusing globes or not, provided the conditions in regard to candle-power were complied with. His own impression was that people were much too tolerant of glare in streets. In reality, owing to the dark background against which lamps were seen, brightness was even more important than in interior lighting. He believed that in future much greater efforts would be made to avoid glare in public lighting. It would then be found that "seeing power" by existing illuminations would be vastly improved.

Mr. H. BUCKLEY asked for information as to the bearing which the work done on glare had to the Home Office Factory-lighting Regulations. Would it be possible to express in a different way what Mr. Stiles had said? If, instead of giving the equivalent background brightness, one could state that with certain illumination the exposure of sources of a given candle-power reduced the ability of the eye by a definite amount, then one could form some impression of the loss in efficiency owing to glare.

Mr. L. E. BUCKELL said that the paper was a very interesting one. He thought that Mr. Stiles was perhaps a bold man in remarking that the vague knowledge of 20 years ago was now being reduced to definite and precise knowledge, though he had certainly gone some distance towards justifying the statement. The air had been cleared wonderfully, and general knowledge had been brought into the region of more or less definite and quantitative knowledge.

He thought that Mr. Dow hit the nail on the head when he said that the chief point arising from the work done by Mr. Stiles was the question of contrast. The question whether one got glare or not was determined mainly by the relative brightness of different objects.

The question had been asked whether experiments put the limit of Bordoni's principle at 1° or 3°. This was a vital point. For instance, in the case of lamps in shop windows seen at, say, a distance of six feet away, a lamp with a clear globe gave rise to uncomfortable glare, whereas a lamp with a frosted globe did not even though the angle subtended at the eye by a filament might be quite small. With regard to opal or pearl lamps, he agreed that the description of such lamps as "glareless" was unscientific, but it was understood by the public. The avoidance of glare was a practical matter of the greatest importance. Very many sources of light in ordinary use subtended an angle at the eye of less than 1°. It would be a pity if it were assumed that in such circumstances a diffused source was no better than an unscreened bare lamp of similar candle-power.

There was the further question whether there was any justification for the view that the eye was more sensitive to glare when the light came from one direction rather than another. He was speaking of the impression that the angle with regard to the eye should be specified. Was it a fact that light coming from below, with a certain background, caused more discomfort than light coming from above? The greatest discomfort glare that he ever experienced was that due to reflection of light from white paper on a desk when he was trying to write or read. It was a most difficult and troublesome thing to avoid.

He thought that it was an excellent idea to distinguish between disability glare and discomfort glare. The question was which of the two was the more likely to do harm to the sight. In the case of disability glare there was no doubt at all that it involved making a greater unconscious effort to see, and therefore exhausted the eye nerves to a greater extent. In the case of discomfort glare he imagined that an irritation was set up which would have some after-effect.

The paper had made one hopeful of hearing something more on the same subject from Mr. Stiles when experiments had been carried further. It appeared possible to arrive at some conclusions which could be readily understood and applied, and which would enable lighting experts to eliminate glare in the same systematic way as the provision of adequate illumination.

Mr. J. E. RAPHAEL, referring to possible injury to the eye, enquired whether it was correct to assume that both disability glare and discomfort glare were prejudicial? There was, for instance, the disability glare experienced when looking into a bright source of light or in testing arc lamps or using searchlights. In the case of searchlights there was a covered glass, so that they could neglect, to some extent, the effects of ultra-violet rays. Working in a room where glare was prevalent had a distinct after-effect on the eyesight, and it might be that permanent disability might thus be caused.

He had always felt, as Mr. Dow did, that so far as discomfort and the physiological effect were concerned, the question of intrinsic brilliancy seemed to be the best criterion of glare. The effect differed with different people. Some could endure a higher intrinsic brilliancy than others. In dealing with illumination everybody aimed at a sort of standard, and some similar guidance in regard to glare was needed.

The operating table had been mentioned. In such circumstances could one obtain such a high intrinsic brilliancy that disability arose? He could not help thinking that there must be some maximum intrinsic brilliancy that ought not to be exceeded. There was, however, the question of the distracting effects from other lights. Suppose that a surgeon had been working at an operating table for some time, and he looked up and found that the walls of the room had a different scale of brightness than the table. Would his vision be impaired by reason of the mere fact that there was this difference, and would he see less well when he looked down again? This problem had actually arisen in the construction of new operating theatres, and surgeons were having fancy colours put on the walls. He had heard it said that the right colour was dead black, but some surgeons with whom he had had to deal preferred light green. In such cases he took care to see that the colour was not a dark forest green. The old idea was to use white tiles. Although there had been no complaint of glare from the terrific illumination on the table itself under ordinary conditions, there had been complaint of glare from the reflection on the tiles.

They had to study quantitative, scientific and absolute methods. If Mr. Stiles could help members on a few of the points which had been raised they would, he thought, go away from the meeting feeling that they had learnt even more than could be learnt by studying the paper carefully at home with diagrams. He himself would have to study the paper and diagrams for three or four hours before he knew a hundredth part of what Mr. Stiles knew about the subject.

The CHAIRMAN, in winding up the discussion, congratulated Mr. Stiles again on his paper, which had given rise to an interesting discussion. As the hour was late, he would ask others who wished to take part in the discussion to send in their remarks in writing to the Hon. Secretary. He invited Mr. Stiles to deal briefly with the various points raised, and to amplify his remarks in his final reply, which would be published in the journal.

Mr. L. MINCHIN (*communicated*): Amongst the many interesting points in Mr. Stiles's paper, he was particularly interested in the maximum angle at which area of source begins to enter into the expression for disability glare. This lighting condition was, however, he believed, stated by Mr. Stiles to be solely the result of ambiguity in measurement of angle θ. If this be so, the stated maximum 1° loses much of its significance. It would seem, however, that there must be a condition at which brightness and not candle-power becomes the predominating factor in glare, quite apart from considerations of difficulty of evaluating θ, which, after all, is not mathematically insuperable. Suppose, for example, as an extreme case, that an annular glare source were situated with the line of vision passing vertically

through the centre. The angle θ is now perfectly definite. Is it then a fact that the disability glare would be no less than if a point source on the circumference were substituted?

Perhaps Mr. Stiles would be good enough to give his views on the matter, and give us the benefit of his experience regarding the behaviour of glare sources which subtend an angle greater than this critical angle. It will be recalled that Bordoni, after coming to similar conclusions as Mr. Stiles regarding disability glare, concluded his paper by suggesting that the problem of glare might to some extent be overcome by the use of translucent refracting plates, which will, of course, provide a large area. It will be seen that in the case of street lighting there is a distinct possibility of angles over 1° being encountered in this way. For example, a refracting plate 12 inches across at a distance of less than 50 feet will subtend an angle of greater than 1°, and it would seem a very interesting point to know whether by this means the glare can be reduced, at least where expressed as a proportion of the augmented candle-power.

Mr. HOWARD LONG (*communicated*): As the time for the discussion was limited at the last meeting, I would like to take advantage of the invitation of the President to contribute to the discussion by correspondence.

In the first place I would like to compliment the author on the very interesting way in which he delivered his paper, which deals with a somewhat abstruse and involved subject. I was a little disturbed at the author's statement that a bare lamp hung out of the line of vision in a room with light surroundings would not produce any glare resulting in decreased ability to see, but would only cause discomfort. It has always been my belief and experience that glare, however produced, results in reduced ability to see. It has been explained in the past that this was due to the glare causing the pupil of the eye to contract, and thus reducing the amount of available illumination for visual acuity.

I am therefore disposed to suggest that all forms of glare come under the author's classification of disability glare, and that all forms of glare cause discomfort, and that, therefore, there can be no distinct division of classification as given in the paper. The only classification of kinds of glare which are found to apply in practice are those of direct glare and reflected glare, which result in the same effect of disability to see.

The difference between the above view of the subject and that given in the paper seemed to be the difference between the results experienced in practice and the results obtained from academic tests. At the same time I do not wish, in any way, to deprecate the value of this paper in arriving at quantitative results. In fact I consider that the work done is so valuable and the subject so complex that a continuance of this study is warranted.

As a matter of interest I would like to know how the author measured a brightness of 10.6 millilamberts.

Mr. W. S. STILES, in reply: In replying to the discussion, I think it will be preferable if I deal first with the question raised by several speakers concerning the angular size of the glare source. I will try to amplify the treatment of this point given in the paper, indicating at the same time the answers to the questions raised.

To begin with, the equivalence between glare sources of equal candle-power but of different brightnesses and areas holds good *only as far as the disability effect produced is concerned*. The principle definitely *does not hold for the discomfort effect*. According to Bordoni's researches, *which dealt solely with disability glare*, the principle holds good so long as the source does not subtend an angle at the eyes greater than a certain limit. Now, in Mr. Buckell's example of shop-window lighting, he is expressly concerned with *discomfort* glare. Thus Bordoni's principle is not applicable, and whether the limiting angular size specified by the principle is 1° or 3° is irrelevant as far as this case goes.

It should be emphasized that when the limiting angle laid down by Bordoni, beyond which his principle fails, is exceeded, there is no change in the essential *character* of the glare effect. Bordoni's experiments indicated merely that as the source exceeds the limiting angle, then the effect on the brightness difference threshold becomes a little less than that of a point source producing the same illumination at the eye. There is, however, no abrupt change. To take an analogy, if a screen is held at a considerable distance away from a squirrel-cage filament lamp, the illumination on it is proportional to the inverse square of the distance away. As the lamp is approached, however, a certain limiting position is reached when, owing to the finite size of the source, the inverse square law *begins to break down*, and the illumination becomes a little less than that produced by a point source of the same candle-power. There is nothing particularly significant about the limiting position found in this way; it will depend, for example, on the accuracy with which the illumination is measured. Bordoni's limiting angle is a magnitude of the same category. The actual value is given by Bordoni in his earlier papers as "several degrees," and in later work as 1.5°.

Since Bordoni's pioneer work the influence of glare source size on the disability effect has been examined very comprehensively by Holladay. Among Holladay's experiments is the experiment suggested by Mr. Minchin, in which an annular glare source is compared with a point source situated on the circumference. Holladay reaches the interesting conclusion that Bordoni's principle holds without any limit as to the size of the glare source, provided that in comparing with the point source of the same candle-power the latter is placed at a glare angle θ which is a suitably chosen average of the glare angles of the different parts of the extended glare source. Thus, whether one adopts Bordoni's view, according to which the deviations he obtained between the disability effects of large and small glare sources of equal candle-power are due to a true brightness effect, or whether Holladay's conclusion be accepted and any deviations are attributed to an ambiguity in θ (which, as Mr. Minchin points out, can be eliminated), it is, I think, only a correction term which is involved, and in practical cases of serious disability glare this will not be a determining factor.

So much for glare source size and disability effects.

Now the *discomfort* effect of a glare source is determined chiefly by its brightness compared with that of the background. Thus, if the candle-power of a glare source is kept constant, and its size is increased, the consequent decrease in brightness will result in *a first order reduction* in discomfort. This quite unmistakable reduction in discomfort is, I think, the cause of the difficulty experienced by many, in realizing that there is no corresponding decrease in disability. Before leaving this subject it should be pointed out that, even though in most commonly occurring cases it is the brightness of the glare source which determines the discomfort effect, as shown by the work of Nutting, Luckiesh and Holladay, yet, if a glare source is so small or so distant that the eye cannot resolve the separate parts of it, i.e., if it subtends an angle at the eye of only one or two minutes of arc, then it is almost certain (although direct experimental evidence is lacking) that the discomfort effect will be determined by the candle-power, and not the brightness, of the source.

Mr. Dow raises the question of the British Standard Specification for Street Lighting, in which the glare is estimated on a candle-power basis. This is so, I imagine, because the framers of the specification felt that visual disability was the mostly likely source of danger in the street, and had to be dealt with first. A clause restricting discomfort might be introduced in a revised specification, and in that case the brightness of the source would certainly have to satisfy conditions.

In reply to Mr. Buckell's question on the sensitiveness of the eye to glare light from different directions, as regards disability the experimental evidence indicates very little difference in the effect with the glare source above, below, to the right or to the left of the direction

of vision. Other workers have mentioned that the discomfort effect for glare light from below is most serious.

Both Mr. Raphael and Mr. Buckell refer to the after-effects of disability and discomfort glare. I think where disability is unaccompanied by discomfort there is less likelihood of harm to the eyesight than in the reverse case, but the whole question of permanent after-effects is a difficult one, and I know of no evidence on the point.

The suggestion of Mr. Raphael that too high an intrinsic brightness of the general field may itself result in disability is, I think, shown to be the case by the curve of Fig. 2. $\frac{\delta B}{B}$, which measures the insensitivity of the eyes, has its minimum value at B = = 1 candle/square foot. For higher brightnesses B, the sensitivity is less. The surgeon's occasional glances up from an intensely illuminated operating table to a surface at a different brightness level must result in a brief period of insensitivity on glancing down. This might last a fraction of a second, several seconds, or more, depending on the brightnesses involved and the duration of the rest period. If higher brightnesses were visible on the walls than on the table, a case which might arise by specular reflection of light sources in glazed tiles, the insensitive period would be longer than if the wall brightnesses did not exceed those of the table. Very low wall brightnesses would also be undesirable. The use of coloured walls raises fresh points which investigations now in progress at the National Physical Laboratory may help to elucidate.

In reply to Mr. Buckley, it is interesting to note that the maximum brightness of light sources permitted in the Home Office Factory-lighting Regulations is 5 candles/square inch, or $0.072.10^4$ candle/square foot, which is of the same order as the maximum permissible brightness in an ordinary living-room, as worked out in the paper, on the basis of Nutting's formula (see Table II).

Alternative methods of representing the results of the disability glare experiments can be devised, as suggested by Mr. Buckley, but I think the equivalent background-brightness method is preferable because of its probable relation to a fundamental physiological notion —retinal adaptation.

In answer to Mr. Cunnington, I do not think the formulæ given in the paper cover the case of flicker mentioned. As regards the general relationship between unpleasant flickering effects and the glare from a steady source, perhaps the connection can be expressed by saying both phenomena depend on contrast; in the former case the contrast is extended in time, in the latter it is extended in space.

Despite Mr. Long's comments, I must still adhere to the view that disability and discomfort glare effects are independent manifestations. Separation into direct and reflected glare is rather a classification of sources of glare than of glare effects. The brightness of 10^{-6} millilamberts (3.10^{-7} candles/square foot) mentioned in the paper refers to the brightness range in Nutting's experiments. Nutting's papers are not very explicit on the point, but I imagine the method used was to reduce in a given proportion a known measurable brightness, by interposing filters of known transmission, or by moving the source of light farther away from the screen and applying the inverse square law.

Department of Scientific and Industrial Research

Mr. F. E. Smith, C.B., C.B.E., D.Sc., F.R.S., Director of Scientific Research at the Admiralty, has been appointed by His Majesty the King in Council to be Secretary to the Committee of the Privy Council for Scientific and Industrial Research, with effect from the 1st October, 1929, on the resignation of Mr. H. T. Tizard, C.B., F.R.S.

Architectural Lighting

(Proceedings at a Special Meeting of the Illuminating Engineering Society, held in the Assembly Hall of the Birmingham Chamber of Commerce, on Tuesday, October 22nd, 1929.)

IN our last issue we alluded briefly to the special meeting of the Illuminating Engineering Society which was held in Birmingham on October 22nd. Prior to the meeting several members, who had travelled up to Birmingham with Mr. Maitland, had the pleasure of dining with Mr. W. Y. Anderson and other friends at the Engineers' Club. At the subsequent meeting, which commenced in the Assembly Hall of the Birmingham Chamber of Commerce at 7 p.m., there was an excellent attendance.

Dr. J. W. T. Walsh (President of the Illuminating Engineering Society, was briefly introduced by Mr. W. Y. Anderson, who explained that Mr. C. C. Paterson (President for 1928–29) had been unavoidably prevented from being present.

Dr. J. W. T. WALSH, on taking the chair, expressed regret at Mr. Paterson's absence owing to domestic illness. Mr. Paterson, however, had sent a telegram wishing success to the meeting, and this was read out by the Chairman.

Proceeding, Dr. Walsh assured the company that in any event he would not have missed this meeting. He had looked forward to visiting Birmingham on this occasion. All of those who had the Society's interests at heart were looking forward with confidence to the formation of the first local centre of the Society in this city. He said that because he felt that here would be a proper place to start what would be a completely new chapter in the Society's history. It was felt that the Society would never be able fully to do the work it set out to do so long as it confined itself to London. It could only achieve what it desired through the medium of active, hard-working local centres. Therefore it was that they looked forward with confidence to the formation of a centre in this city. They had a temporary measure whereby those living in the country could become country members by paying a subscription of one guinea instead of two guineas. That arrangement would serve until local centres were in operation all over the country. The Chairman concluded by saying that he would not take up more time, because he was sure those present wanted to hear Mr. Maitland. Those who had heard his paper in London knew he had made a close study of what was perhaps the greatest novelty in the lighting art for many years. Possibly some might be a little startled at some of the ideas that Mr. Maitland would illustrate, but in the course of time many new things would be taken more or less as a matter of course. They were much indebted to Mr. Maitland for letting them hear something of these new ideas.

Mr. WALDO MAITLAND then read his paper on "Architectural Lighting," which was on similar lines to that delivered in London on March 19th. The address was illustrated by numerous lantern slides showing novel methods of interior lighting developed both in this country and abroad, and there were some striking examples of devices developed since the date of the meeting in London. The address was listened to with close attention. The audience had the advantage of having in their hands a number of copies of the journal containing Mr. Maitland's paper, as read in London, which were distributed at the commencement of the meeting.

The CHAIRMAN then invited Mr. Justus Eck, whom he referred to as one of the pioneers in the illuminating engineering industry in this country, to open the discussion.

Mr. JUSTUS ECK said he was a firm believer in good illumination, and he was also interested in efforts to imitate daylight—an aspect of artificial lighting which had not been discussed in this paper. Mr. Maitland's paper was a a very timely one. There would be an International Illumination Congress in this country in 1931. He believed that Birmingham would be one of

the cities visited by those attending the congress. Perhaps Mr. Maitland had in mind some idea of there being in Birmingham in 1931 examples of the architectural illumination of which he had spoken. Continuing, Mr. Eck remarked that absence of glare was one of the most important things in lighting, and this could be secured either by the subdivision or by the multiplication of sources of light, or by the use of extensive luminous surfaces. One might have gained the impression from the illustrations that architectural lighting was a novelty confined to other countries. But this was not so. The first illumination of this kind, they would be pleased and proud to hear, was carried out at Windsor Castle in the time of Queen Victoria. The inspiration of this form of lighting had come, as had so many other things, from the brain of a Scotsman, Mr. Gordon Craig, the pioneer in stage lighting. Mr. Craig's work might well be one of the sources of inspiration of other countries. We in this country were often the originators of an idea, but found difficulty in getting it taken up, with the result that eventually it was developed abroad. He rather gathered the impression that this form of lighting might be rather expensive, because there were so many units of light. They aim at getting electric supply undertakings to give a special rate for this form of lighting, which remained on for a long period, generally at a time when the factories were not working, so that it helped towards securing a good load factor. One thing that had brought forward the possibility of good architectural lighting was the immense improvement in the texture, finish and size of glassware. Glass was not easily affected by chemicals, and although other materials had been used he thought it would be found that glass was the predominating medium. It was a pity the very beautiful illustrations they had seen could not reveal the effects of colour. He wished that some of those in the North of England could go to London and see the wonderful showroom of the Lighting Service Bureau. It would be an excellent idea to have a similar model room in Birmingham. Possibly the Birmingham Electric Supply Department could contribute towards making architectural lighting more familiar. It was a form of lighting which could also be applied in private houses, where beautiful applications were possible.

Mr. E. A. REYNOLDS, Chairman of the E.C.A., said their thanks were due to the lecturer for giving such striking views of this form of lighting on the Continent. There were certainly not many examples of this form of lighting in England at present, and he would rather like the opinions of some of the architects on the subject. In his opinion some of the arrangements did not quite meet his ideal of architectural beauty. Thus, in some of the illustrations, the units were almost wholly in the form of rectangles and cubes, and he wondered why circles and spheres, which would be just as effective, should be left out. The showroom of the Lighting Service Bureau had been mentioned, and he most strongly advised everybody who had not seen it to go to London and do so.

Mr. W. A. JACKSON, Chief Engineer of West Bromwich, said one thing which appealed to him as a supply engineer was the marvellous load that might be got from this type of lighting. They should try and encourage the supply of current at a penny a unit for this purpose. He was somewhat doubtful, however, how far this form of lighting would be acceptable from the architectural point of view. The lighting might be very effective at night-time, but it did seem to him that some of the arrangements detracted from the appearance of the buildings during the day.

Mr. W. P. PODBURY asked if there was any data as to foot-candle intensities, the average wattage per square foot, and what was the depreciating factor due to dust.

Mr. MAITLAND, in reply, said he did not think that even in Germany they could give this information at present. They were concerned primarily with "effect," and consumption seemed to be almost a minor consideration.

Mr. PODBURY then put a question concerning the blending of daylight and artificial light, where both existed, so as to avoid glare.

The CHAIRMAN, in reply, said it was generally considered bad to blend uncorrected artificial light with daylight, but recent experiments had shown that perfectly satisfactory results could be obtained by the use of artificial daylight lamps. As proof of this he cited an occasion when he took a friend into a room where there was no daylight, only artificial daylight. The visitor looked round, and said, "Yes, that is very nice, and now will you switch on the artificial light?" He had a shock when he knew it had been artificial light all the time. Some people, however, found artificial daylight lamps a trifle cold, and preferred the warmer tone of the uncorrected light; but they could not have it both ways.

Mr. J. S. DOW, referring to the illustrations, commented upon the fact that most of them were of shops, restaurants and theatres. One would like to hear more of this form of lighting being applied to public buildings of distinction, because it seemed to him that in this field the real possibilities of architectural lighting as an art existed. He believed there were one or two public buildings which had been put up recently in which the lighting was of architectural type. There was the further consideration that with this form of exterior lighting the diffusion of light helped materially in the illumination of streets. Some of these buildings evidently required an immense amount of electricity. At the discussion in London it was pointed out that some of the buildings illustrated took an amount of current similar to that which would be required for the entire lighting of a town of the size of Epsom or Windsor. The addition of a load equivalent to that of a small town might prove something of a problem to electric supply undertakings.

Mr. ANDERSON, referring to the remarks of the last speaker, said that a big load would be welcomed by a supply undertaking if it were of reasonably long duration. He also wished to say how much he had enjoyed the paper. The author had given them some very excellent ideas on shop lighting. They had one or two shops in Birmingham in which small block units of reflected or deflected light were used, and he had made a point of speaking to the owners about the cost. It was interesting to learn that it had been their experience that their lighting consumption was less than was the case when ordinary methods of lighting were used.

Mr. JACKSON asked if the examples in Paris were "off-peak" lighting, and if there were any restrictions on the consumer.

Mr. MAITLAND said he had not gone into that. The prices per unit were generally about 3d.

Mr. WM. DOUBLEDAY, as an architect, said the subject was an exceedingly interesting one, and he was sure they would pursue the subject into which Mr. Maitland had initiated them. Personally he thought indirect lighting generally preferable to direct lighting, on the ground that it was more agreeable to the eye.

Mr. SMITH expressed the opinion that the new Carreras Building in London was a finer example of this form of lighting than many of the illustrations they had seen.

Mr. F. E. LAMPLOUGH said that when buildings of an unusual character were being dealt with a bizarre effect was often desired, but fashions of this kind were likely to change rapidly, and people might get tired of them in a very short time, and would wish for something likely to remain attractive for a longer period of time. It would be interesting to know if the trend of opinion on the Continent was in favour of indirect or flood lighting. He mentioned the example of the Berne Cathedral lighting as being rather extraordinary, but it might at first offend one's taste to see a building of this nature lit up so brilliantly.

Mr. MAITLAND, replying briefly to the discussion, said that he would probably take the opportunity of answering the questions more fully in the *Journal*, when it appeared. He agreed that architectural lighting might

sometimes involve doubts from the practical point of view. But, in order to obtain really fine architectural results, some degree of sacrifice in practicability might be necessary. It should be borne in mind that *effect* was the main thing in this form of lighting, and other considerations might become of secondary importance.

On the proposition of the CHAIRMAN, a vote of thanks to Mr. Maitland for his paper was carried with acclamation, following which Mr. ANDERSON expressed the thanks of the meeting to Dr. Walsh for presiding.

In conclusion, it was announced that another meeting would be held in Birmingham on Friday, January 24th, 1930, when a paper dealing with industrial lighting would be read by Mr. E. A. R. Werner (H.M. Superintendent Inspector of Factories for the Midland Division).

Progress in Illumination

The Annual Report of Progress issued by the Illuminating Engineering Society, U.S.A., which appears in the October number of the *Transactions*, appears to be much briefer than in former years, when the volume of data presented was apt to be somewhat overpowering.

It is remarked that there have been no radical departures in the field of production of light during the past year. Improvements in detail of incandescent lamps have, however, been introduced, and there has been further standardization. A feature of interest has been the production of very high candle-power lamps for use in motion-picture studios and for aviation. In industrial lighting a tendency towards supplementing general lighting by local lighting for individual machines has been noticeable. There seems no reason why suitable lighting units for this purpose should not be incorporated in the design of the machine. Increased attention has been paid to avoidance of glare.

In connection with street lighting continually higher intensities are being furnished for "White Way" lighting, and this has led in turn to the use of higher illuminations in shop windows with the object of eliminating troublesome reflections in the window glass. Many window displays are now illuminated during daylight hours.

In the kinema studios the introduction of "talkie" films has resulted in a greatly increased use of incandescent lamps of 10 kw., noiselessness of operation being now an important consideration. Studio intensities have become almost standardized at about 500 foot-candles, with 1,500 foot-candles on the principals. With "Technicolour" processes even higher intensities are required.

In motor-vehicle lighting the use of the depressible-beam system, based on the use of two-filament lamps, is still increasing. The use of traffic-control signals is also becoming even more general. There has been substantial progress in aviation lighting, many new ports having been equipped for night flying.

In photometry increased use is being made of the photo-electric cell, and improvements in the direction of greater stability and closer resemblance to the sensitiveness of the human eye have been made. A novel application of photo-electric cells has been found in the "traffic-counter," which automatically registers the number of persons passing between the cell and the source of ultra-violet light.

Lighting Conditions in South Africa

This forms the title of a contribution by Mr. H. A. Tinson, which appears in the *Transactions* of the Illuminating Engineering Society (U.S.A.), for October, 1929. South Africa has its special problems, for example those involved in its vast mining industry. It is stated that at the Premier Diamond Mines in the Transvaal, perhaps one of the greatest examples of industrial floodlighting, the night production is actually somewhat higher than that by day. In the chief cities the lighting of the main streets appears to compare favourably with that of European cities. Great progress is also being made in commercial lighting. It is evident that South Africa is a land of opportunities.

International Illumination Congress

To be held in Great Britain in Sept., 1931

DURING recent years there has grown up a general recognition of the value of international conferences, which serve many good purposes in facilitating unity of action on matters of common interest, in assisting standardization, and especially in promoting exchange of experience, personal intercourse and friendly relations between experts in different countries.

This tendency has been especially evident in connection with illumination. Illuminating engineering societies exist in Great Britain and the United States, Germany, Austria, Holland and Japan; and everywhere there are developing organizations which aim at bringing about better lighting.

Experts on such a rapidly developing subject as lighting naturally desire to exchange views and learn of activities elsewhere, and this wish has led to continuous growth in the extension of the movement towards international treatment of the subject, which had its origin in the International Photometric Commission, founded in 1901. The expediency of broadening the scope of this body so that all illuminants and all aspects of lighting might be represented was soon recognized. In 1913 effect was given to this desire by the reconstitution of the Commission on a wider basis as the International Commission on Illumination, to which are linked National Committees in all the chief countries of the world. The outbreak of war naturally imposed a check on its development, but subsequently meetings in Paris (1921), Geneva (1924), Bellagio (1927) and New York (1928) revealed continuous progress. The International Illumination Congress and the session of the Commission held in the United States last year probably formed the most important conference on lighting matters ever held. It was marked by great enthusiasm, being attended by 500 delegates from the following countries: Austria, Belgium, France, Germany, Great Britain, Holland, Italy, Japan, Sweden, Switzerland, and the United States.

As our readers will recall, it has been decided that the next International Illumination Congress is to be held in Great Britain in 1931. All interested in the cause of better lighting are uniting to render this congress an outstanding success. In this country the machinery for the study of illumination is perhaps more perfectly organized than in many other places, and the aid of all the leading scientific and technical bodies interested and of organizations concerned with gas and electric lighting is being secured. The National Illumination Committee of Great Britain, in co-operation with the Illluminating Engineering Society, will be responsible for this important event. Several committees are already at work on the arrangements, fuller particulars of which will be announced in due course.

The International Illumination Congress, which will take place during the period September 3rd to 13th, 1931, will be combined with a *voyage d'etude* of places of interest in England and Scotland, so that other cities besides London will share in the work of the Congress. Papers dealing with the most varied aspects of lighting will be presented, and these will be grouped so as to ensure that topics of special local interest will be dealt with at each centre. The Congress will be followed by the technical meetings of the International Commission on Illumination, which will be held in Cambridge during September 13th-19th.

We understand that material progress has recently been made in determining the arrangements for the Congress, and no doubt we shall be in a position, sometime during the coming year, to present a detailed programme for the information of readers.

The Honorary General Secretary of the Congress is Colonel C. H. Silvester Evans (c/o The Illuminating Engineering Society, 32, Victoria Street, London, S.W.1), to whom all communications should be addressed.

The Application of Electricity to Roads, from the Point of View of Street Lighting and Traffic Signals*

By W. J. JONES, M.Sc., A.M.I.E.E.

EXAMINATION of the daily press reveals a keen interest on the part of the public in street lighting, especially in so far as it contributes to the improvement of public safety and convenience. Improved facilities for travelling from one town to another enable comparisons to be made, and deepen this impression. Good street lighting is automatically associated with well-conducted local government. At present many opportunities of effective lighting are lost. As a nation we are proud of our bridges, which are embodied examples of engineering skill and, in some cases, artistry. Millions of pounds have been spent on their construction, yet it is difficult to find in this country a bridge that is worthily illuminated. The new bridge over the Tyne at Newcastle is a wonder of engineering; if a small expenditure in proportion to its high cost were expended on lighting it would at night resemble a veritable string of jewels spanning the river. Why should not lighting elements now be incorporated in the parapets of bridges; why not luminous parapets and illuminated turrets? When the authorities decide to build the new Charing Cross bridge let us hope that lighting may be incorporated in its design, so that the architectural lines may be perpetuated after the fall of darkness.

Proposed Central Public Lighting Department for London.

At the last meeting of this Congress a central public lighting department for the control of the lighting of London was suggested. Street lighting in London is still in the hands of some 35 different authorities. The anomalies are still being multiplied, and the general "patchiness" of the lighting of London continues. The city of Berlin, where similar conditions existed, has recently effected co-ordination, and already a marked improvement in the character and quality of the street lighting is visible.

This problem of rationalization of public lighting is not confined to London, but is apparent in nearly every large city throughout the country. Unfortunately, few towns have the services of a qualified lighting engineer, but where this step has been taken notable improvements in street lighting have resulted. London lacks a co-ordinating engineer for street lighting. Moreover, only one or two of the executive officers in charge of street lighting are members of the Association of Public Lighting Engineers.

Arterial and By-pass Roads.

Co-ordination is also needed in connection with lighting on arterial and by-pass roads. Great strides have been made during recent years in the construction of modern highways, yet their utility is frequently limited by inadequate lighting. In many instances whole stretches of the road passing through suburban areas still remain unlighted, although the road has been completed for some while. The question arises, "Whose business is it to light the new road?" In some instances the charge for lighting such roads to a reasonable standard would be an unduly heavy burden on the smaller communities through which the road passes. In other areas the utility of the new thoroughfares is reduced due to the short-sighted policy of not incorporating street lighting as an integral part of the planning of the thoroughfare, and usually only motor cars provided with powerful headlights will use these roads after dusk. For example, the Urban District Council of Finchley has provided reasonable lighting along part of the North Circular Road, but the contiguous length of the road in the neighbouring district is unlighted.

The Coast Road from Newcastle is another example where great difficulty exists in getting adequate and uniform lighting, owing to the several lighting authorities which have jurisdiction over it.

Yet another example is the Paisley Road outside Glasgow. The Glasgow Corporation lights the Glasgow-Paisley road quite well within its boundary, while the Paisley Borough Council provides reasonable lighting within its borders. An intervening lighting authority lights a short stretch of the main road with a few ordinary gas lamps, but the rest of the road through which trams, buses, and other traffic pass is left at night in inky blackness. Unless there are houses alongside the road no authority wants to undertake the lighting of the stretch of the road within its territory. This problem remains nobody's business—neither that of any local authority nor of the Government. Undoubtedly, so far as county roads are concerned, the County Council should be made the lighting authority, and the lighting of these main roads should receive at least as much attention as their construction and maintenance by the aid of the Road Fund. There are also directions in which some national co-ordinating force would be an advantage, and it should be possible in such cases for the question to be referred to the department of a Minister of State. As an instance, the comprehensive exhibit of street-lighting appliances installed in Sheffield last year may be mentioned. It would have been of national benefit if this could have been made a permanent exhibit for the general use and inspection of lighting authorities throughout the country.

Recent Developments in Lighting Apparatus and Methods.

In the next section of the paper attention is drawn to the influence of the British Standard Specification for Street Lighting. The specification of a minimum mounting height of 13 ft. has led to an extension of many unduly short columns, and the increased mounting height has improved the general quality of the street lighting.

An instructive diagram in the original paper illustrates the steady increase in the number of units used for public lighting by electricity during the period 1921-28; in the latter year more than 110 millions of units were used for this purpose. The replacement of clear-bulb lamps by internally frosted lamps, especially in the case of fittings mounted on relatively low posts, has given rise to greater visual comfort. As such lamps are somewhat cheaper than those with clear bulbs, and the loss of light involved by internal frosting is negligible, such lamps should be widely used for public lighting, with the possible exception of a few instances where "directive" lighting is employed. Attention is also drawn to the improved efficiency of electric incandescent lamps, as revealed in the most recent B.E.S.A. specification.

Traffic-Control Signals.

Whilst luminous signals have been widely adopted for traffic control in the United States, their development in this country has been relatively slow, and work in this direction has so far been mainly experimental. The Royal Commission on Transport in its first report

* Abstract of a paper read at the Public Works, Roads and Transport Congress (1929).

recommended the use of automatic light signals for traffic control, which, in order to secure uniformity throughout the country, should be erected under the supervision of the Ministry of Transport. This question of uniformity received the attention of the Association of Public Lighting Engineers at their Conference at Brighton, and at a special meeting convened for the purpose in March, 1928, at which an introductory paper on the subject was read by the author. It is, therefore, gratifying to note that quite recently the Ministry of Transport has issued a memorandum laying down recommendations for the installation of these traffic signals. This communication should do much to clarify the situation. The three-colour system is recommended, the relative positions of the colours being: Top, red; middle, amber; bottom, green.

It would be valuable at a later stage to have more positive recommendations on the colour specification for the signal glasses themselves. No doubt the work on coloured glasses for signal purposes which is being carried out under the auspices of the National Illumination Committee will assist in this direction. The memorandum specifies a definite size of electric lamp by giving its rating in watts; this seems to be a commonsense procedure, since while it may be possible to manage with a smaller wattage in freak apparatus, its general utility would be restricted.

In the United States it has become the practice to employ a traffic signal lamp of special design, while on the Continent the apparatus is designed to accommodate ordinary standard lamps. From this point of view of standardization and cheapness in maintenance, it would appear desirable to determine the type of lamp which should be ordinarily employed. The lamp should operate at the normal line voltage of the supply in the area.

Traffic Signs.

Here, again, is a subject which requires very much more complete co-ordination. Traffic signs of a more or less standard character are installed by the Automobile Association and the Royal Automobile Club, in accordance with a circular letter issued by the Ministry of Transport in 1921, but there are many instances where the installation of these signs and signals are insufficiently understood. In some areas no attempt is made to light up traffic signs, while in others the traffic sign is incorporated as part of the street-lighting equipment. The latter procedure is inadvisable, since it invariably results in reducing the effectiveness of the street-lighting system and seldom performs satisfactory service as a traffic sign.

Another important fact is that the brightness of a sign which may be quite adequate in rural areas is quite unsatisfactory in city areas where there are competing light sources, such as traders' signs, or where the general brightness of the street lighting mitigates the effectiveness of the sign.

A common defect is for the light source itself to be visible, its high intrinsic brilliancy causing discomfort and reducing distinctness of vision. The effects of glare are particularly important on country roads, where the eyes of drivers are dark adapted and therefore extremely sensitive to glaring conditions. Light sources should therefore be invariably screened.

The problem of standardization of traffic signs received attention at a meeting of representatives of European countries at Geneva, and as a result a code has been prepared which coincides almost completely with the recommendations of the Ministry of Transport. It is gratifying to note that Great Britain took such an active part in the preparation of this code, and that some progress has since been made in changing signs to conform to this international agreement.

The main drawback, however, to progress in effecting this desired standardization of road signs throughout the country is the parochial outlook of many of the authorities responsible for their installation. A questionnaire was recently circulated to borough engineers throughout the country. An analysis of the 250 replies received showed that only some 50 per cent. of the direction signs met with the recommendations of the Ministry of Transport, or were supplied by the Automobile Association. Moreover, many boroughs did not use danger signs at all!

Still more remarkable is the variety of signs used to indicate safety zones or islands, and hardly any arrangements are made for the signs to be illuminated. It seems axiomatic that traffic signs, with possibly one or two exceptions, should convey their message equally as well after dark as during the daytime, and it is surprising that so few lighted traffic signs are installed throughout the country. This is still more remarkable when it is realized that a sign lighted after dark is very much more effective than during the daytime. This is amply proved by the results of tests on the visibility of warning signs which were chiefly carried out by Mr. S. B. Langlands in Glasgow at the commencement of last year, in which the visibility and legibility of the message at night-time was ascertained for a variety of illuminated warning signs. (The results of some of these tests are given in an appendix to the original paper.)

It has been suggested that where signs require to be lighted at night a part at least of the cost of installation and upkeep should be charged to the Road Fund, and it appears that local authorities can already obtain financial assistance. It is of the utmost importance that the whole problem of erecting these signs should be considered jointly with the general provision of street lighting, and not developed as a separate problem divorced from the allied subject of providing illumination for visibility.

Æsthetic Considerations.

In conclusion, reference is made to the disfigurement of many cities by the display of clumsy traffic notices and signs. There is undoubtedly opportunity for the display of more artistic feeling than is in evidence at present. Even in important areas of leading cities ordinary wooden painted signboards of clumsy design have been clamped to lamp columns, and the lighting arrangements are frequently inadequate and crude. In this respect there is a great contrast with the neat and graceful designs erected in some Continental cities. The problem should be considered from a national standpoint. The present recommendations of the Ministry of Transport require revision. A valuable document on this subject is the Report of the Committee of the American Engineering Council on Traffic Signs, Signals and Markings. In almost every instance it is recommended that the sign shall be illuminated and clearly visible at night. Undoubtedly the publication of a similar comprehensive report in this country would be valuable.

The Light-Reflecting Powers of Flowers and Foliage

A paper on this somewhat out-of-the-way subject was presented by Mr. S. G. Hibben at the Annual Convention of the American Illuminating Engineering Society, held in September last.* Green foliage in general reflects relatively little light; tree leaves usually reflect about 15 per cent. in summer, grasses somewhat less, whereas the brighter flowers may reflect in some cases 75 per cent., and on an average 50 per cent. The author has sought to study spectroscopically the changes of leaves in autumn, and he mentions many interesting little bits of information. To botanists and horticulturists such an investigation is of considerable interest, for it touches on many debatable points, for example the exact part played by the intensity of sunlight, and especially ultra-violet light, in determining the coloration of flowers. Mr. Hibben's investigation is also of more than academic interest to those concerned with the floodlighting of parks and gardens. Of the possibilities in this direction Mr. G. E. Shoemaker spoke with enthusiasm, remarking that experimental shrubbery lighting was an exceedingly interesting problem for lighting engineers to tackle in their spare time—cheaper than golf and more soul-satisfying!

* *Trans.* Am. Ill. Eng. Soc., October, 1929, p. 752.

POPULAR & TRADE SECTION

COMPRISING

Installation Topics—Hygiene and Safety—Data for Contractors—Hints to Consumers

(The matter in this section does not form part of the official Transactions of the Illuminating Engineering Society and is based on outside contributions.)

Electric Light and the Party

(Contributed by the E.L.M.A. Lighting Service Bureau).

AT the festive season of the year it is generally desired to provide something of novelty and distinction in the way of home decoration. Unfortunately, in the past there have been many instances of calamities occurring due to the use of decorations made of paper and other inflammable materials used in conjunction with naked lights of a flame character, such as candles, night-lights, etc., but at the present time, with the more general use of electric light, this danger is being overcome. Electric lighting provides not only the safest possible form of illumination but also provides a very much greater scope than was ever possible with any other medium for obtaining decorative effects. Apart from the fire risk, the use of candles in conjunction with, say, paper Japanese lanterns, is not ideal, due to the possibility of damage to floor coverings, from falling candle grease, but very beautiful effects can be obtained without any of these disadvantages by using Japanese lanterns illuminated by means of small candle-power (15 watts) Pearl lamps. Small electric light sources of this character give just that desired degree of light to obtain the utmost value from the effect of the decorative lanterns, and, by means of lamp holders and a length of flex connected to plug points, very beautiful decorative schemes for Christmas and other parties can be devised and employed at a comparatively small cost, so far as the necessary materials and electrical energy consumption is concerned.

By the application of a little ingenuity, the housekeeper need by no means be restricted to the customary form of Japanese lantern for decorative electric lighting schemes on festive occasions, for by the use of crepe paper and the employment of a few electric lamps connected by flex to convenient points in the room, most charming effects from that of brilliant sunshine to pale moonlight can be produced. The range of colour-sprayed lamps which are now available is of material advantage in this connection, since their use enables any particular colour tone to be introduced with the utmost facility. Then again, with the aid of a few simple tools, decorative light sources ranging from luminous fruit to fantastic shapes can be quite easily constructed. The wire frames may be covered with either paper, silk or vellum, and a lamp of suitable size and colour should be employed to give the desired lighting effect. Thick cardboard or 3-ply wood form an excellent backing for decorative paper, which can be employed to provide a "stage set" or scene to occupy one or more walls of the room. The rising sun can be readily introduced into the scene by means of a brightly coloured orange disc with a lamp placed below so that the light is reflected on to the disc. The effect of this will be very similar to a device now to be seen in many oculists' windows.

In addition to the above suggestions, which give great scope to the ingenuity of the decorator, there exist the well-known strings of decoration lamps which provide ready-made effects which can be applied in the simplest manner possible. These lamps are available in festoons, and can be applied for either decorating the room, table or Christmas tree, and, again, they are far safer to employ than the old-fashioned types that relied upon a candle, and, in general, they give a much more pleasing effect. Decorative schemes can be improved enormously by a well thought-out system of switching which enables the introduction of subtle effects and variations in light intensity and colour, introducing thereby a most charming atmosphere of novelty to the occasion.

The house can also be made to impart its cheerful atmosphere to the surrounding district by means of decorative exterior lighting, and with the flexibility and convenience now available from electric light sources a dwelling may be entirely transformed into a fairyland after nightfall, inspiring the guests and adding its quota of cheer and goodwill to all who pass during the festive period.

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The Illumination of the Lecture Theatre at the Institution of Electrical Engineers

By An Engineering Correspondent

THERE is no place in the United Kingdom where a demonstration of the most suitable and economic lighting is more desirable than at the Institution of Electrical Engineers, where everyone naturally expects the electric lighting to be all that is possible and appropriate. Willing as the Institution may be to comply with this demand, it has perhaps been somewhat hampered by the architectural features of its lecture theatre, designed for both day and artificial light, and therefore embodying a translucent ceiling, subdivided into square panels by massive beams. The rich but dark wooden panelling which extends from floor to cornice has also proved an obstacle to an entirely satisfactory result.

Realizing the importance of better lighting, the Council decided to take advantage of the last sessional recess to have the installation replanned concurrently with improvement in the decoration. Two members of the Council, Mr. C. C. Paterson, the President of the International Illumination Commission, and Mr. H. T. Young, whose name is closely associated with recent progress in architectural illumination, were entrusted with the task of carrying this decision into effect, and in doing so co-operated with the architect of the building, Mr. H. P. Adams.

It is but reasonable to assume that certain restrictions were imposed on the extent and class of the contemplated improvement by the traditions connected with the room, its probable future appearance and decorative finish, but nevertheless the results now achieved can be described as entirely satisfactory.

The ground floor of the lecture theatre occupies an area of 2,968 square feet, being 56 feet wide and 53 feet from the audience entrance doors to the wall behind the Council table. There is a height of about 25 feet up to the boldly projecting cornice, and a space above of approximately five feet, filled up with a rounded area of plaster surface, leading up to the translucent or daylight ceiling divided into 64 panels, each filled with 48 panes of cathedral glass.

The large number of evenly placed small-power lamps originally placed above the cornice has been maintained, but the illumination, and consequently the consumption of electricity, has been considerably reduced. The flood lanterns have been retained and four additional ceiling fittings have been supplied. Measurements of the effective illumination on the working plane made before and after the modifications show that the average has been increased about 75 per cent., with a diminution of the current consumption of 8 per cent., and that the diversity factor is notably small over all the seating accommodation with a mean of approximately 5 foot-candles.

The results of the alteration are not confined to intensity of illumination, but include also greater comfort for the audience and an improved decorative appearance. The entire surface of the rounded contour from the cornice to the ceiling was previously left pure white and reflected a brilliant light. But owing to the numerous lamps placed at even intervals this important feature of the room lost much of the decorative effect of its high relief. This effect has now been modified by the adoption of a harmonious colour scheme with a depth of tint suited to the luminous result desired, and arranged to accentuate the relief to a satisfactory degree. The uncomfortable brightness hitherto existing on this surface having been thus obviated, the eye now rests with pleasure, free from any discomfort, on this important feature of the structure. The table given below indicates both the number and the consumption of the lamps used for this section of the installation.

The translucent ceiling has been appropriately modified by the introduction, into the central parts of four of its panels, of severely rectangular daylight fittings built up of panes of opal glass projecting downwards, and provided with so large a number of lamps that the fittings become luminous objects rather than dispersing screens, and are consequently not unduly prominent, although they provide that desirable element of visible and direct illumination that has hitherto been absent from the theatre. The flood lanterns which hitherto were the sole source of light available for the top-light illumination are retained and used semi-directively.

The lamps in the theatre and their respective consumption is shown in the following table:—

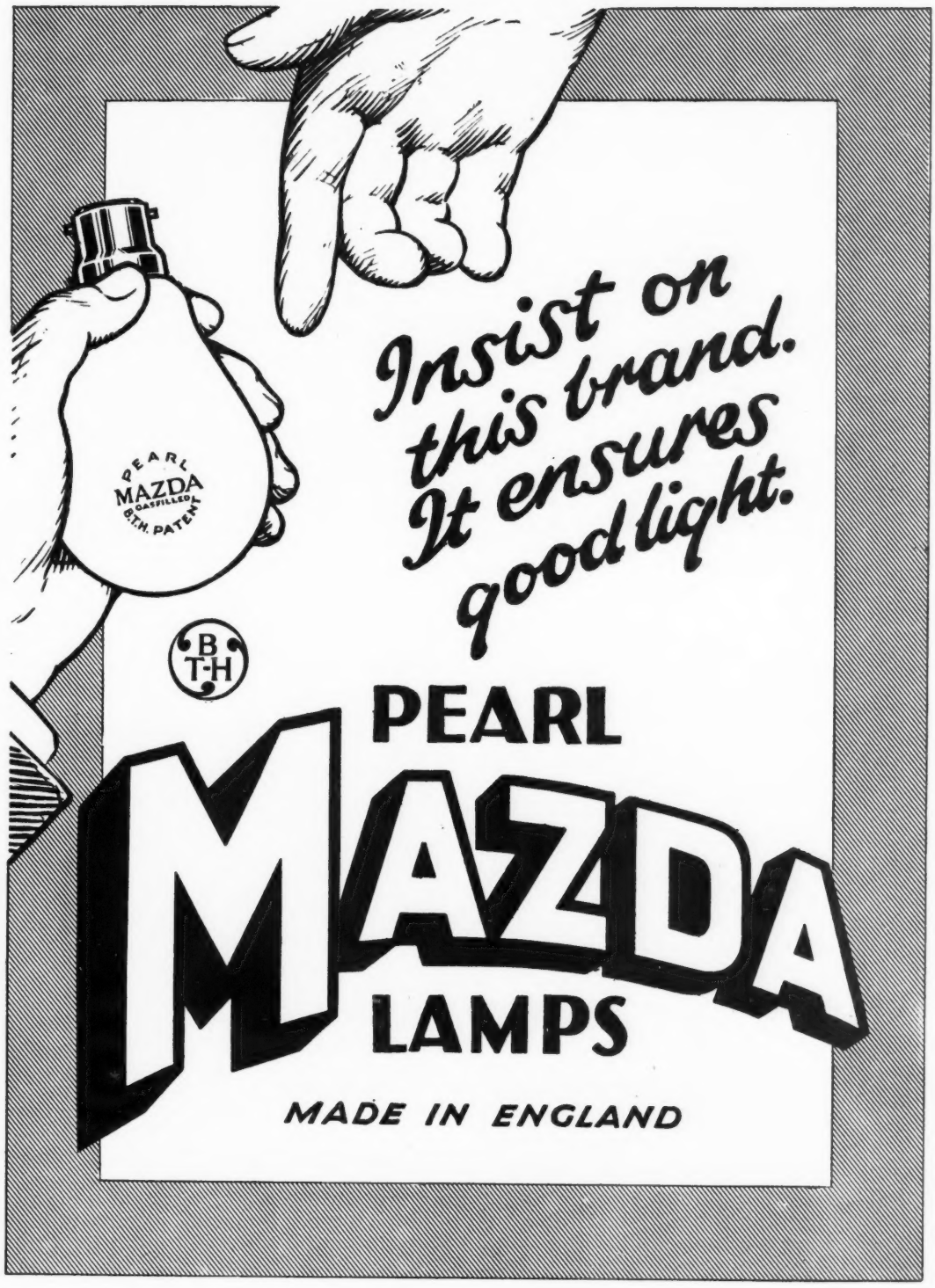
TABLE.

Position.	Fitting.	Previous Scheme. Lamps.	Previous Scheme. Total watts.	Present Scheme. Lamps.	Present Scheme. Total watts
Cornice	.....	780	15,600	780	8,970
Ceiling,	8 Floodlights...	8	4,000	8	4,000
,,	4 Laylights.....	—	—	192	4,980
			19,600		17,950

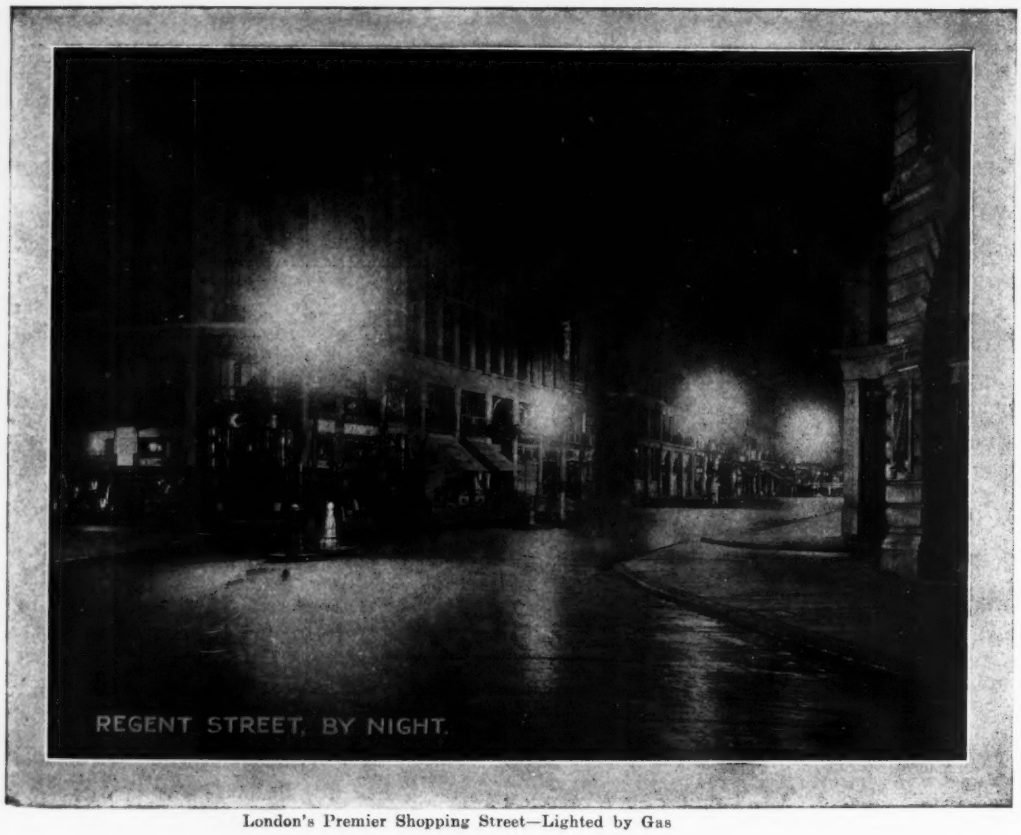
The dark panelling which surrounds the theatre is undoubtedly antagonistic to the production of brilliant lighting effects or useful dispersion, but is being gradually modified by the addition of oil paintings of pre-eminent men whose names will always be associated with the work of the Institution; hitherto there were four such pictures, but they have been supplemented this session by those of Clark Maxwell and John Hopkinson. These more responsive and multi-coloured surfaces are provided with individual fittings, which, although supplying glare-free illumination, adequate for good observation of the subjects, do not either add notably to the general illumination or, if retained alight, interfere materially with the observation of illustrative items projected by the lantern on the screen behind the presidential chair.

The results attained cannot be adversely criticized in any direction, but we feel there is no harm in suggesting that the world-renowned names of Ampère, Ohm, Volta, Kelvin, etc., inscribed on the pilasters separating the wood panels, might be gilded without introducing any discordant feature, while adding further unobtrusive attractiveness to the auditorium.

The difficulty of the problem so successfully solved may be better realized by describing the theatre as, in some respects, resembling a well having poor light-reflecting sides, which receives all its light from above, but is nevertheless required to be made not merely full of light but so attractive as to give mental repose with a feeling of comfort. That such an uninspiring object has been coped with in so efficient and agreeable a manner must be, to all associated with the improvement, as well as to the large body of trained engineers that visit the institution, an abiding pleasure and recompense for the expenditure of their time and money. This applies especially at the present moment, when every possible preparation should be made to impress on the many illuminating engineers from all parts of the world, visiting this country for the International Illumination Congress in 1931, that we attack our problems of illumination from the proper aspect; in other words, we do not run riot with extravagant floods of light, but apply the characteristic faculty of our countrymen for solid economic progress.



3262 THE BRITISH THOMSON-HOUSTON CO., LTD.

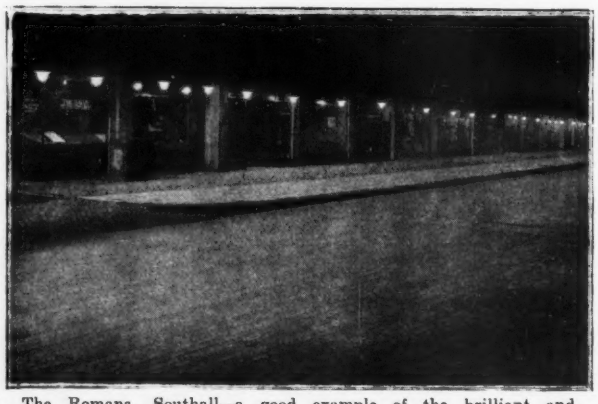


London's Premier Shopping Street—Lighted by Gas

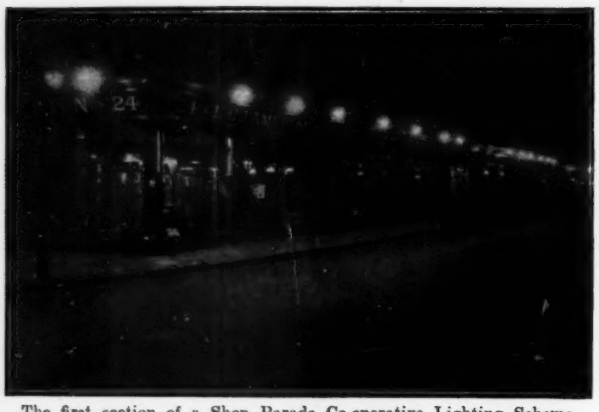
The Shop Front as a Selling Force

(*Communicated.*)

MANY enterprising shopkeepers throughout the country are now combining in their efforts to stimulate business in their districts by the adoption of a co-operative system of shop-parade lighting. They are having gas lamps of standard design and illuminating power placed at regular distances along the row of shops, the lamps being fixed, as a general rule, on brackets attached to the buildings. In some cases the lamps are used definitely to illuminate the contents of the windows and the pavement immediately in front of them, care being taken in their disposition to prevent glare in the eyes of those looking in at the windows. In others they are fixed at a greater height in order to illuminate the buildings themselves, the fascias, and also any advertisements which may appear on the frontages. Frequently lamps are installed for both purposes, the lower ones for window lighting and the upper ones for floodlighting. Examples of the different forms of lighting are given on this and the following page. These co-operative lighting schemes have much to be said in their favour. The general appearance of the row of shops is greatly improved by the regularity in height and spacing of the lighting units; and the mass effect of the series of brilliant lighting units attracts the crowds to the neighbourhood.



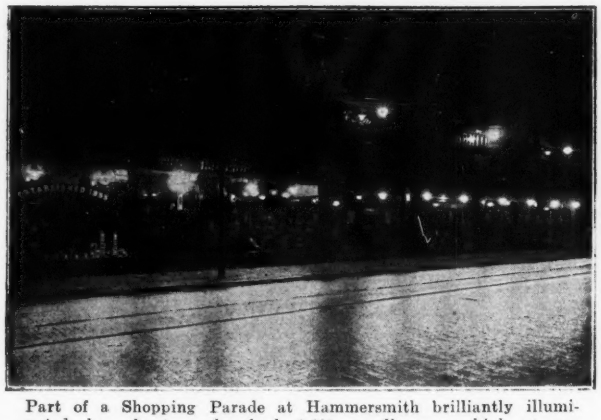
The Romans, Southall—a good example of the brilliant and pleasing effect which can be obtained by the use of a standard system of high-pressure gas lighting for a parade of shops. In this case the owner of the row of shops pays all charges for lighting and includes these costs in the rents payable by the individual tenants. On a foggy night this row of shops stands out as a bright landmark in the district, as gas lamps have peculiarly good fog-penetrating powers.



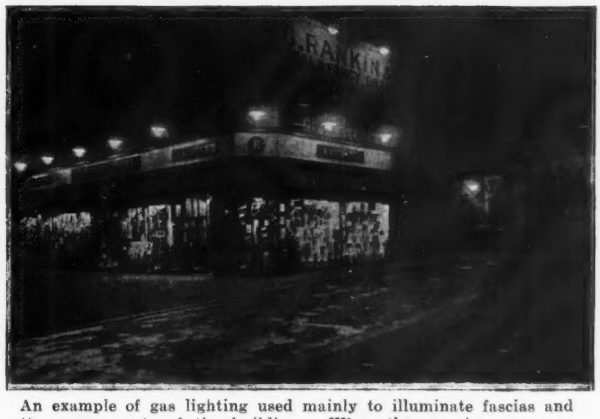
The first section of a Shop Parade Co-operative Lighting Scheme now being installed at High Street, Ealing. The running costs of the scheme were, of course, carefully considered by the Traders' Association before they ultimately decided to adopt high-pressure gas lighting. The lamps shown are left alight each night until 10 o'clock, the shopkeepers being unanimous in their appreciation of the advertising value of a well-lighted parade of shops during those hours of the evening when people are about but shops are closed.

The "All-in" System of Charge.

Some local gas undertakings supply and instal the lamps, light and extinguish them, provide all gas and maintain the lamps in good lighting order for a fixed quarterly charge paid by the individual shopkeepers, the payment varying proportionately with the number of lamps on each shop front. Thus the shopkeepers are provided with a system of lighting which never fails,



Part of a Shopping Parade at Hammersmith brilliantly illuminated by about a hundred 1,000 candle-power high-pressure gas lamps. Most of the lamps are fixed below the fascias, so that they not only illuminate the pavement but supplement the light provided by the interior window-lighting units. A smaller number of lamps is fixed at a greater height to illuminate the fascias, which do not show up as well in the photograph as they do when viewed by passers-by, on account of their black glass background.



An example of gas lighting used mainly to illuminate fascias and the upper parts of the building. When the premises were remodelled recently and provided with modern fascias the owners decided to adopt gas for exterior lighting. This shop is one of a number in the district which are equally well illuminated by high-pressure gas lamps, each of 1,000 candle-power. The lamps are installed, provided with gas, lighted, extinguished, and kept in perfect lighting order by the gas undertaking.

which is always kept in excellent order, and which imposes no work of any kind on themselves. Each shopkeeper also has the distinct advantage of knowing at the beginning of the quarter the exact amount of his bill in respect of outside lighting. In some districts this "all-in" charge system is equally available for individual shopkeepers who desire to have distinctive and reliable shop lighting; and wherever this is the case full advantage should undoubtedly be taken of it.

Inexpensive Maintenance of Lamps.

In other areas slightly different arrangements are made. Another quite common plan is as follows: The shopkeeper purchases the lamps outright or hires them, pays for all gas used as registered by his meter, and authorizes the gas undertaking to maintain the installation in good lighting order at a fixed quarterly charge.

High-pressure Gas Lamps.

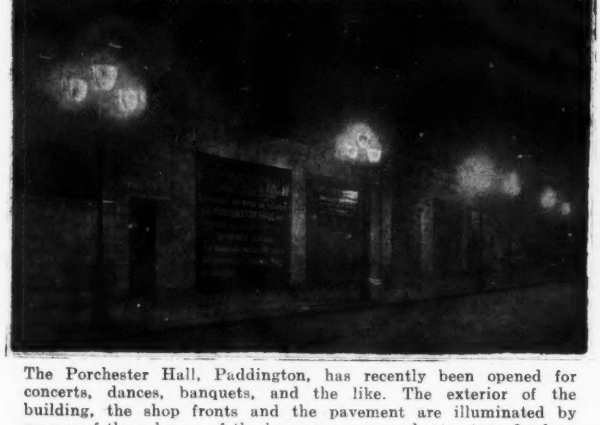
Most of the modern lighting units shown in the accompanying illustrations require gas at a higher pressure than that provided from the ordinary main. They thereby give a considerably increased candle-power per therm used. Whenever there is a high-pressure gas main in the street high-pressure gas lamps should be installed. Even if no high-pressure main exists it will sometimes be distinctly advantageous to provide a small local compressing plant to increase the pressure—for parade-lighting schemes, or for any other installations of, say, twenty or more lamps.

Superheater Low-pressure Gas Lamps.

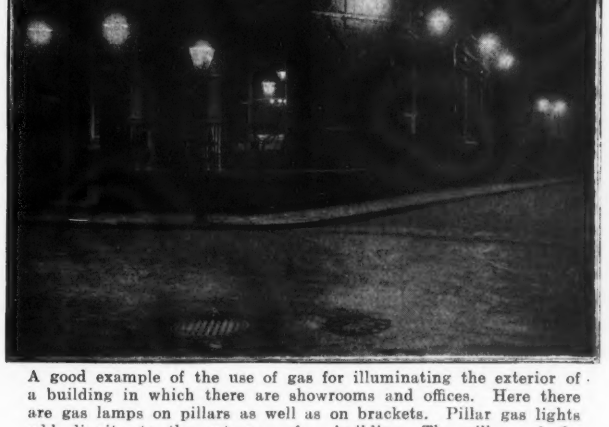
For smaller lighting schemes there are now available some exceptionally good low-pressure lamps with superheaters which can be provided with clusters containing any number of mantles from two up to fifteen. There is no difficulty in obtaining any desired candle-power from this type of lamp. The colour of the light is almost identical in both cases; the lamps give out rays which are a very close approximation in colour to those of the sun, thus showing off goods at night-time in almost their natural colours. They are particularly effective, too, in penetrating thick fogs—a most important point.

Lighting Windows after Closing Hours.

A word may be said finally in favour of the growing practice of leaving lamps alight after closing hours. The cost of the gas is negligible in proportion to the additional business which may so easily result from the display of goods at a time when many people who have been at work all day are on their way home or are out for a little exercise. In cases such as those described in which the gas undertaking lights and extinguishes the lamps, no difficulty will arise as regards the turning out of the lamps; but for individual shopkeepers who wish to keep their lights burning until, say, 10 o'clock, and who have not arranged with their local gas undertaking to turn them out, there are reliable clockwork devices which will automatically extinguish the lights at any given time, thus making it unnecessary for anyone to attend at a late hour to do this work.



The Porchester Hall, Paddington, has recently been opened for concerts, dances, banquets, and the like. The exterior of the building, the shop fronts and the pavement are illuminated by groups of three lamps of the low-pressure superheater type fixed on columns placed near the edge of the pavement. Each lamp contains a cluster of three inverted mantles giving a light of approximately 150 candle-power. The total light provided is 2,700 candle-power.



A good example of the use of gas for illuminating the exterior of a building in which there are showrooms and offices. Here there are gas lamps on pillars as well as on brackets. Pillar gas lights add dignity to the entrance of a building. The pillars of the gates leading to the courtyard of Buckingham Palace and also of those leading to the Houses of Parliament are surmounted by modern gas lamps. They are kept in good lighting order by the skilled men of the local gas undertaking.

E.L.M.A. Lighting Service Bureau

TWENTIETH ILLUMINATION DESIGN COURSE.

We gather that the twentieth Illumination Design Course of the E.L.M.A. Lighting Service Bureau, announced in our last number, is proving a great attraction. Recent lectures have been delivered by Mr. S. Anderson on "Industrial Lighting," by Mr. N. Lingard on "Floodlighting," and by Mr. R. W. Maitland on "Modern Architectural Lighting." In this lecture Mr. Maitland emphasized the importance of close co-operation between the architect and the illuminating engineer in the planning of new buildings, and his remarks were well illustrated by the special architectural lighting rooms at the Bureau. (If there remain amongst our readers any who have not yet seen these rooms we advise them to pay a visit to Savoy Street.) The final lecture, on December 2nd, by Mr. W. J. Jones, is allotted to "General Lighting Problems."

We may mention, however, that this Illumination Design Course now forms but a small part of the complete educational activities of the Bureau. We have before us particulars of nearly 60 lectures that have been given in the course of the past two months. A few of these were delivered in London, but the majority were far afield, such places as Cardiff, Sheffield, Bristol, Torquay, Southampton and Edinburgh being represented on the list. A feature of interest is the effort being made to reach different circles of the public, many of the addresses being given to chambers of commerce, trade bodies and local rotary clubs.

Sheffield Illumination Society

An interesting and educative evening was spent by about 40 members and friends of the Sheffield Illumination Society, on the 12th November, when a visit was made to the Sheffield General Post Office.

The intricate apparatus in the trunk exchange, and the varied instruments in connection with the telegram system, etc., in the instrument room, were found to be of particular interest, the many technicalities and developments being fully explained by competent guides.

In the sorting office the party had a glimpse of what happens to correspondence, parcels, etc., after being handed in, and were informed that one particular machine for stamping letters, postcards, stamped 800 per minute.

Another interesting item was the "Accounts" Department, where the various postage, insurance stamps, etc., were on view. Much information was given here as to the facilities available regarding the Air Mail Service and the Post Office system generally.

Illuminated Signs

A USEFUL HANDBOOK.

Readers may recall that some time ago we alluded to a well-illustrated handbook on show-window lighting, prepared by Dr. Putnoky, of the Osram G.m.b.H. in Berlin. We have now before us a booklet from the same source, which is due to Mr. W. Kircher, and is executed in similar style, dealing with illuminated signs. This booklet contains approximately 50 pages, a good feature again being the assembly of descriptive matter on the left-hand page, and the reproduction of day and night photographs on the right. Whilst some of the views relate to "illuminated signs," as the term is understood in this country, e.g., lettering executed in small incandescent lamps, others illustrate more recent methods, such as the use of transparencies; and others again might be regarded as coming under the heading of "architectural lighting." An interesting tendency, revealed in some of these pictures, is the use of flat, white letters or bands executed in white material, showing lettering in silhouette. These luminous bands form a prominent feature in many modern Continental displays, and we understand that this principle of emphasizing lines is receiving considerable support from architects abroad.

Recent Books on Illumination

We have to acknowledge the receipt of two new works on illumination, both available from Messrs. Chapman & Hall. "A Textbook on Illumination," by Professor Wm. Kunerth, is the outcome of the course given at Iowa College for many years to senior electrical students. "Electric Street Lighting," by Mr. C. J. Stahl, may be regarded as a more specialized work. We hope to deal with both these volumes in our Review column very shortly.

Personal Notes

An interesting recent event was the departure for South Africa of Mr. E. S. Evans, who has been District Engineer of the Lighting Service Bureau for the North-East Coast since its inception in 1925. During the past year Mr. Evans has been manager of the E.L.M.A. stand at the North-East Coast Exhibition, and there must be many members of the Illuminating Engineering Society who have come in touch with him and appreciated his enthusiastic outlook on lighting problems and his bright and genial personality. Mr. Evans will be in charge of lighting development work in South Africa, so that, although his resignation means a loss to the lighting industry in this country, South Africa will be the gainer. A number of friends assembled to say farewell to Mr. Evans when he left London, and the writer had an opportunity of conveying good wishes shortly before his departure. There are great opportunities for lighting developments in South Africa, and Mr. Evans has kindly promised to keep us in touch with progress there.

* * * *

Our readers will be interested to learn that Mr. Howard Long, A.M.I.E.E., has joined the Benjamin Electric Ltd., to take charge of the lighting engineering service.

Following his apprenticeship and service in the R.N.V.R. during hostilities, Mr. Long studied at the day technical college of the Battersea Polytechnic Institute, taking the final diploma and City and Guild certificate. Since then he has specialized in illuminating engineering, firstly with Holophane Ltd., and subsequently with Metro-Vick Supplies. Mr. Long held the position, with the latter firm, of manager of their illuminating department for the last four years, during which time he was responsible for many large installations; noteworthy amongst these being the Greyhound Track, Wembley Stadium, which installation he supervised and designed in all its aspects, including wiring. In addition, Mr. Long is well up in design work and has several patents to his credit. Mr. Long has thus excellent qualifications for his new post, in which we wish him every success.

* * * *

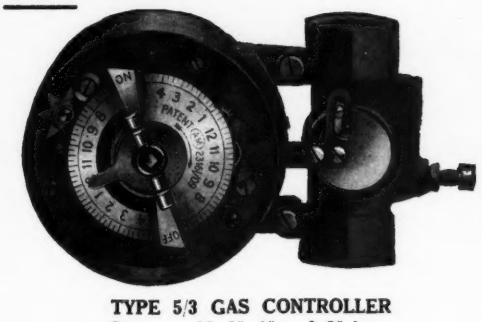
Readers will be interested to hear of the recent marriage of Mr. Reginald H. Palmer, O.B.E., principal of Palmer's Publicity Service, the well-known trade advertising experts, to Miss Muriel Irene Maude Cracknell, the soprano. This happy event took place at St. Martin's-in-the-Fields, on Friday, November 15th. The officiating clergyman was the Rev. Hugh L. Johnston. The ceremony was attended by a very large circle of relatives and friends, who afterwards attended the reception at the Victoria Hotel, Northumberland Avenue, W.C.2. The duties of best man were capably carried out by the bridegroom's brother, Major Clifford H. Palmer, who is also very well known in the trade. We feel sure that our readers, who include many friends of Mr. Reginald Palmer, will join in wishing him and his wife every possible happiness and good luck.

Shop window lighting controllers

Shop window lights left illuminated after the usual closing hours will bring more business to the shopkeeper.

By installing a Newbridge Controller, windows can conveniently be left lit until any desired time. *Write now for full details.*

Gas



TYPE 5/3 GAS CONTROLLER
Sizes .. ½", ¾", 1" and 2" iron.

Ideal for control of interior and exterior gas shop lighting, flat lighting, advance heating of water, linotype metal, etc.

The model illustrated is fitted with a selective device to prevent operation on Sundays and/or any other day, or days, per week.

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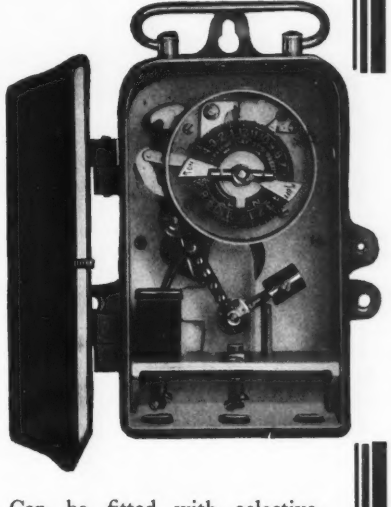

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TRADE NOTES & ANNOUNCEMENTS

TWO NOVEL TYPES OF DECORATIVE LIGHTING UNITS.

We have received from Messrs. Hailwood & Ackroyd Ltd. particulars of two pleasing decorative lighting units, which are illustrated in Figs. 1 and 2. The first of these shows a fitting which is 24 ins. in diameter and is octagonal in shape. It is built up with ornamental metalwork and is provided with satin-finish panels or with panels tinted in various colours. This lighting unit is regarded as specially suitable for the lighting of large interiors (restaurants, hotels, cinemas, etc.).

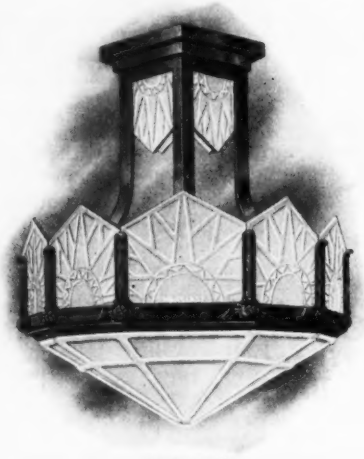

FIG. 1.—A pleasing Octagonal Unit of Novel Design.

The second lighting unit, shown in Fig. 2, is a diffusing globe of somewhat unusual shape, and is likewise equipped with ornamental metalwork. Thus both units illustrate the tendency to combine decorative metalwork with diffusing glass. We understand that both have been introduced quite recently.

FIG. 2.—A Pendant Globe with Ornamental Metal Work.

TWO NEW BENJAMIN UNITS.

We illustrate below two new types of units recently developed by Benjamin Electric Ltd.

The first of these (Fig. 1) is a compact type of unit furnishing "artificial daylight." This unit is supplied in three sizes for use with standard gasfilled lamps of from 60 to 200 watts, and combines the familiar one-piece R.L.M. reflector with a daylight-glass front. Features of interest are a novel spring-clip band with locking lever, which ensures positive tension on the band of the cover at all times, and a detachable top flange, which allows the whole unit to be detached from the flange and lampholder, thus ensuring easy wiring.

FIG. 1.—The Visor Artificial-Daylight Unit.

The Benjamin Visor Dusto-Proof Reflector (Fig. 2) is an entirely dust-proof fitting, a special heat-resisting domed glass front being secured to the Benjamin one-piece R.L.M. reflector above, by a device similar to that used with the Visor artificial daylight unit. Like the former, it is made in three sizes for lamps of from 60 to 200-watt capacity, and is specially suitable for industrial works where dust-proof qualities are essential and where a robust but scientifically designed lighting unit is needed.

FIG. 2.—Visor Dust-proof Unit.

These two units, and manyother new and interesting types are illustrated and described in the recently published Benjamin catalogue (No. 1100), which can be obtained on application to the company at their well-known address in Tottenham.

EDMONTON'S LATEST BUILDING.

Considerable interest attaches to the fine new building recently opened as a furniture emporium by Messrs. Bradley's at Fore Street, Edmonton, which comprises three spacious floors containing over 20,000 square feet. A feature of this fine new building is the series of three large and lofty shop windows which enable everything appertaining to the home to be viewed in comfort.

The lighting has been carefully studied; a flood of light without glare is directed on to the furniture displayed in the windows by the use of Siemens electric lamps and scientific shop-window reflectors. For the lighting of the various floors Siemens "Ultralite" fittings are used; these handsome fittings resemble globes of light and provide a shadowless illumination of high intensity, due to the provision of a glass top in place of the usual metal canopy. A composite view of the imposing interior is shown in the accompaning illustration.

The North Metropolitan Electric Power Supply Co., Sales Department, Electricity House, Palmer's Green, were responsible for the wiring and lighting scheme of this imposing building, and the building and shop fittings were erected by W. T. Yates, building contractors, Edmonton.

Two Views of Messrs. Bradley's Emporium at Fore Street, Birmingham.

"DA-RAY" UNITS.

The simple but pleasing form of unit, which is shown on the left, is the new "Da-Ray" type recently introduced by The Wholesale Fittings Co. Ltd. These units utilize "Supastone" three-ply glass, and are characterized by low absorption and an exceptionally even distribution of light. Another feature is the daylight effect yielded by this special variety of glass, and it is stated that this is achieved in a remarkably efficient manner. These and many other novel types of lighting units may be seen at the showrooms of the company in Commercial Street, a view of which appeared in our last number.

SPEEDWAY LIGHTING.

We have received from Messrs. Tungsram Electric Lamp Works (Great Britain) Ltd. a night photograph of the new speedway of Messrs. Motordrome Ltd., at Coventry. Good lighting is naturally of great importance in dirt-track racing, owing to the high speed at which competitors travel. Badly lighted tracks are a source of danger to riders. In this case, judging from the picture, the lighting appears to be quite efficient. The installation was carried out by Messrs. W. T. Hellaby & Co., of Birmingham, and the lighting is effected exclusively by seventy-five 500-watt Tungsram lamps.

CONTRACTS CLOSED.

The following contracts are announced :—

SIEMENS ELECTRIC LAMPS & SUPPLIES LTD. :—

Great Western Railway; for the supply of Siemens gasfilled electric lamps during a period of 18 months.

METRO-VICK SUPPLIES :—

Great Western Railway; part contract for the supply of "Cosmos" gasfilled and "Cosmos" vacuum type ordinary and train-lighting lamps.

LIGHTING TRADES LTD. :—

We are informed that Messrs. Lighting Trades Ltd. has supplied lighting fittings for the *Airship R.*101, to the special requirements of Messrs. Haslam & Newton.

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Copy due 15th of the month.

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SINCE the year 1909, when the Illuminating Engineering Society was founded in London, it has been the official organ of the Society.

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